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BRIEFLY TOLD.

A CORRECTION.—Our notification of the time and place for the July meeting of the Guild of Gas Managers, published in our issues for June 24th and July 1st, was in error, the Executive Committee having determined, as is the usual custom, not to hold meetings this year during July, August and September.

GOVERNOR ALTGELD'S VETO OF THE FRONTAGE BILL.—In our current item columns will be found the full text of the veto by Governor Altgeld of the measure enacted by the Legislature of the State of Illinois for the protection of the proprietors of gas and electric lighting companies in that State from the attacks of blackmailers. In substance the bill directed that hereafter the local authorities of the cities, villages and incorporated towns of Illinois might not issue franchises to gas and electric light companies, unless the promoters of the same could show petitions, signed by the owners of a majority of the frontage on each mile of street, declaring that such owners consented to the occupation of the streets by the companies for the conveying of their products. On its face the bill was a just one, and closely resembled the street surface railroad law in operation in this State, which, in the main, has been found to work well. Apart, however, from its intrinsic merit, and as the bill is dead, its abstract merits are of no especial interest just now, the main thing that attracts us is the remarkable language used by the Governor in giving to it its quietus. He cooly declares: "It is claimed that the municipal authorities in some cities make it a practice to grant franchises to new gas companies, and that the old companies are compelled to buy out the new companies, or, what amounts to the same thing, are obliged to submit to being blackmailed in order to prevent the municipal authorities from granting ordinances to new companies. It is claimed that the old companies should be relieved of this kind of extortion." Yes, Mr. Governor, it is true that blackmail, "or what amounts to the same thing," has been markedly manifest in the granting of gas franchises in the State of Illinois, and it is equally true that you have declared by your action in the case under review that you do not believe in relieving the companies from "this kind of extortion," with the result that those who make a specialty of this noisome calling may still have license to ply their vampires' trade. The Governor says also that the existing companies, if they did that which was for their greatest good, should pay no attention to the new ordinance; an application of reasoning which to us seems quite like one's advising the occupant of a house that is on fire not to attempt to extinguish the flames. He has a lot to say about competition and its benefits, meaning, of course, the benefits which accrue to the gas consumer from a multiplicity of gas companies in a populous center, all of which goes to show that his knowledge of the natural laws governing the demand for and sale of artificial light is radically imperfect. The city of Chicago affords about as good an illustration of the evil to the gas consumer of a multiplicity of gas companies as can be found; and anyone at all conversant with the gas situation knows that were it not for the reckless and wicked duplication of gas charters there in the eighties, gas would now be selling there for even less than $1 per 1,000 cubic feet. Think of the stench which accompanied the chartering of the Equitable and Consumers Companies, for instance; and look at the contest that is going on to-day

over the opposition franchise at Peoria, the Council of which city has given its assent to a speculative scheme, pure and simple, in the gas line. The bill vetoed seems to have the right tendency, for if the consumers are being unjustly treated by the existing Companies, the proprietors of new concerns would have no trouble in securing the necessary signatures permitting them to open and to use the streets. The Governor does one fair thing in his veto, where he credits the gas laws of Massachusetts as filling "the double office of protecting established interests on the one hand from blackmail and of protecting the public from extortion on the other." The veto is a weak one, and so does its framer no credit, although all will sympathize over the fact, as he admits himself, that he has been trying to kick back the waters with his feet, and has not been successful.

THE DECISION ON THE BROCKTON PETITION.—In sharp contrast to Governor Altgeld's action is that taken by the Massachusetts Board of Gas and Electric Light Commissioners, whose decision in the matter of the petition for an order reducing the gas rate at Brockton will also be found in our item columns. As is usual with the Commissioners the Brockton case was gone over with thoroughness, and an examination of the findings will admit of no other conclusion than that the Commissioners have decided wisely and well. A noteworthy instance in connection with the case was the weak showing made by the petitioners in respect of their demand for an increase in the candle power, which had been all along well above the statutory requirement.

MESSRS. SAMUEL CUTLER & SONS WANT LITERATURE BEARING ON WATER GAS.—We are in receipt of the following letter from Messrs. Samuel Cutler & Sons, which we publish, accompanying it with the suggestion that any of those interested, and who can forward the matter desired, will communicate directly with the inquirers:

PROVIDENCE IRON WORKS,
MILLWALL, NEAR THE STEAMBOAT PIER,
LONDON, E., June 21st, 1895.

To the Editor AMERICAN GAS LIGHT JOURNAL: We are making a collection of literature appertaining to the manufacture of water gas, and we are desirous of getting as many different pamphlets and circulars of the water gas processes that are or have been adopted in America as we can. We notice in the Transactions, Vol. IV., of the Incorporated Institution of Gas Engineers (London), page 218, a list is given of many processes, and it has occurred to us that you might be able to obtain for us some, if not all, of the pamphlets and circulars referred to. * * * If you will be good enough to obtain what we require and send them on to this address we shall be happy to remit all charges that are incurred in respect thereto. The following are the names of the various water gas manufacturing processes, the makers of which issue many pamphlets and circulars relating thereto: Allen-Harris, Bujac Crutchett, Dickson, Egner, Fogarty, Gill, Granger, Gross, Hanlon-Leadley, Harris, Kitson, Loomis, Lowe, Martin, Meeze, Munzinger, McKay-Critchlow, McKenzie, Pratt & Ryan, Rew, Rose, Sanders, Springer, Strong, Taylor, Tessie du Motay, Van Steenbergh and Van Syckle. Yours faithfully, SAMUEL CUTLER & SONS.

NOTES.—It is proposed to construct a gas works at Carrolton, Mo.——The proprietors of the City Gas Company, of London, Ont., have taken up all the wooden mains, replacing them with cast iron pipes.——It is said that the capitalist behind J. F. Aldrich, whose application for a gas franchise at Peoria, Ills., has been allowed by the Peoria Council, is John R. Walsh, of Chicago.——Carl Simon, who is the leading spirit in the Gas Consumers Society, of Milwaukee, Wis., was convicted some days ago of selling liquor without a license. Scatch a reformer, and you find—?——Supt. Hubbard, of the Gainesville (Fla.) Company reports that business there is increasing at a ratio well in excess of the best expectations of its proprietors.——The proprietors of the Oil City (Pa.) Gas Company have notified the consumers that the manufacture of gas will be temporarily suspended, the shut down to commence on the 15th inst.——Mr. Charles Patterson has resigned his position with the Citizens Company, Jacksonville, Fla., in order to accept a responsible position with a Boston concern.——The Aurora (Ills.) Gas Company is overhauling its main system, and its experience is such that it will use no more wrought pipes of small diameters. Cast iron is good enough now for Aurora.——The New Bedford (Mass.) Gas and Edison Light Company has declared its regular quarterly dividend of 1½ per cent.——The new rates instituted by the Stockton (Cal.) Gas and Electric Company are as follows: Manufactured gas for lighting, $2 per 1,000; manufactured gas for stoves and engines, $1.75; natural gas, first 5,000 cu. ft. a week, $1; over 5,000 feet and up to 10,000 cubic feet a week, 75 cents; over 5,000 and up to 15,000 cubic feet a week, 60 cents; over 5,000 and up to 30,000 cubic feet a week, 50 cents per 1,000.

Acetylene and the Part It Plays in the Luminosity of Flame.

[A lecture by Vivian B. Lewes, F.I.C., F.C.S., before the Edinburgh meeting of the Incorporated Gas Institute.]

Three years ago, I had the honor of lecturing to you on the occasion of the Murdoch centenary meeting in London; and I chose as my subject: "A Century of Work on the Development of Light from Coal Gas." In that lecture, I traced the genesis of the illuminating gas flame, and tried to make interesting the theories which had from time to time been advanced as to the cause of the luminosity which gives our gas its greatest value. Starting with the enunciation by Sir Humphry Davy of his celebrated incandescent particle theory, I showed you how it had held undisputed sway for over half a century, until Dr. Frankland's attack upon it in 1868, in which he suggested that, instead of carbon particles yielding the incandescence, dense hydrocarbon vapors at an excessively high temperature gave the light. This hypothesis, giving rise as it did to an enormous amount of fresh work, increased to a large extent our knowledge of the actions which take place in the flame.

After reviewing the work which had been done in this direction, I pointed out that the chemical actions which were taking place in the inner non-luminous zone of the flame, and which were due to the baking action of the walls of flame upon the hydrocarbons in the gas, appeared to me to be of enormous importance, and to play a leading part in the actions which lead to the emission of light. I was able to show experimentally at that date that, under the baking influence exerted on them, the hydrocarbons of the burning gas were converted into a compound of carbon and hydrogen called "acetylene;" and I surmised that it was this body which, by its decomposition, gave the solid particles of carbon which Sir Humphry Davy looked upon as the prime necessity for luminosity, or which by polymerizing, gave the dense hydrocarbon vapors which Dr. Frankland imagined were heated to incandescence.

Since that time I have continued to work upon illuminating flames and the actions taking place within them. The accidental discovery of a comparatively cheap method for producing calcic carbide, from which pure acetylene can be easily and rapidly prepared, placed a new weapon of research in my hands; and I hope to interest you this morning with the conclusions I have arrived at with regard to the causes which lead to the luminosity of hydrocarbon flames, and to show experimentally some important points on which these conclusions are based.

In a lecture delivered before the Society of Arts last January, I told the story of the discovery of a cheap method of manufacturing calcic carbide by Mr. T. L. Willson, in North Carolina, by which he, taking advantage of the temperature of the electric furnace, fused together coal dust and lime, and by so doing produced a compound of 40 parts by weight of calcium to 2 parts of carbon, to which the name of "calcic carbide" has been given.

The metallic carbides are by no means new creations of the chemist; and it was Sir Humphry Davy himself who, as long ago as the beginning of this century, showed that a compound of potassium and carbon could be produced. Since that time, other carbides have been formed by processes more or less intricate and costly, and the only novelty which can be claimed for the carbide as produced by Mr. Willson is that the simplicity of the method of manufacture, and the low initial cost of the material bring its manufacture within the range of commercial possibility.

Calcic carbide, as I have before stated in my previous papers on this subject, is a dark grey and intensely hard substance, with an almost semi-metallic fracture, and a specific gravity of 2.262. On contact with water, it at once produces a rapid effervescence; the carbide reacting with the water and decomposing it—the hydrogen of the water uniting with the carbon of the carbide to form acetylene, which escapes while the oxygen of the water combines with the calcium of the carbide to form quicklime which, in the presence of excess of moisture, is rapidly converted into calcic hydrate, or slaked lime. For this reason, the calcic carbide cannot be kept exposed to the moisture of the air, as its surface gets rapidly deteriorated. But the formation of lime on the exterior of the mass to a considerable extent protects the internal portion; so that in lumps it does not deteriorate so fast as might be expected, though in small pieces or powder it is so rapidly acted upon as to necessitate its being kept in closed tins or stoppered bottles.

The acetylene generated by acting upon this compound with water is practically pure; and samples made with merely ordinary precautions give, on analysis, upwards of 98 per cent. of the pure hydrocarbon—the

remaining gas consisting of traces of air and sulphureted hydrogen. The intense garlic-like odor of the acetylene so produced is so much more like phosphoreted hydrogen than it is like the smell which we generally associate with acetylene, that one cannot help suspecting the presence of phosphides in it. But to give the smell, the phosphide would have to be present in large quantities; and I have not been able to detect the presence of this compound, even in traces. The solubility of acetylene in water is very much the same as that of carbon dioxide; while it is far more soluble in alcohol, paraffine or glycerine.

When a light is applied to acetylene, it burns with a luminous and very smoky flame. On mixing acetylene with air in equal volumes, on application of a light, the mixture burns with a dull red flame, which gives off volumes of smoke, and leaves a residue of soot behind. In the proportion of 1 volume of acetylene to 1.25 volumes of air, the mixture is slightly explosive; and its explosiveness increases with addition of air, until with twelve times its volume of air it reaches its maximum intensity. The violence of explosion gradually decreases as the supply of air is increased; and a mixture of 1 volume of acetylene with 20 volumes of air is non-explosive.

The gas can be condensed to the liquid state with comparative ease. Ansell found that, at the freezing point of water, a pressure of only 21½ atmospheres is needed for its liquefaction; and the same observer gives 98.6° F. as its critical point—*i. e.*, as the temperature above which it is impossible to liquefy it by any pressure. The pressure necessary at different temperatures is given in the following table:

Temperature. Deg. F.	Pressure. Pounds.	Temperature. Deg. F.	Pressure. Pounds.
— 116.00.....	15.00	32.00.....	322.95
— 28.60.....	135.00	41.45.....	382.20
— 9.40.....	165.15	56.30.....	491.55
+ 14.00.....	255.90	67.27.....	596.76

It may be roughly stated that 1 lb. of the liquid, when converted into gas at ordinary temperature, will produce 14½ cubic feet at atmospheric pressure, and that the volume of the gas is nearly 400 times as great as the volume of the liquid.

There should be no trouble whatever in supplying liquid acetylene on a commercial scale, as it is more easily liquefied than carbon dioxide. Instead of the complex pumping machinery necessary for the liquefaction of that gas, the acetylene can be made to liquefy itself by its own pressure; as, if water is added to the carbide in a closed vessel of sufficient strength, the evolved gas soon creates pressure in the generating vessel. This is increased by the fact that the slaking of the lime causes a high temperature; and as the gas continues to be evolved even after the pressure has risen to above 1,100 lbs. on the square inch, it is only necessary to connect the generating vessel, by means of tubes and drying boxes filled with lime, with a steel cylinder kept cool by means of a freezing mixture, for the gas to liquefy. In this way, cylinders can be filled without the costly pumping apparatus necessary for the carbon dioxide.

The liquid acetylene has many of the physical properties of liquid carbon dioxide; and when it is allowed to escape from the high pressure existing in the cylinder to the ordinary atmospheric pressure, it at once becomes gaseous, and renders so much heat latent that some liquid becomes frozen to a solid, and acetylene snow is the result. This can be used like solid carbon dioxide for the production of low temperatures; and if a light be applied to it, it burns with a smoky flame until the whole of it has been vaporized. Experiments with liquid acetylene and the formation of the solid should only be attempted in a strong draught or in the open air.

When acetylene gas is burnt from a No. 000 or even a No. 0000 union jet burner, the flame, although extremely brilliant, is smoky when the gas is issuing from the nozzle at only ordinary pressures. But on increasing the pressure more and more, the stronger rush of the gas sucks in more air to the flame; and at a pressure of about 4 inches, the No. 000 burner gives a smokeless flame, and develops from the gas an illuminating power which calculates to 240 candles per 5 cubic feet of gas consumed. The necessity for using such pressures as these would, of course, be a drawback in practice; and I have devised a small burner which gives satisfactory and smokeless combustion at pressures even below 1 inch.

The high illuminating value of acetylene, when burned alone, naturally suggested that the gas would be of enormous value for enriching poor coal gas. But in this direction the acetylene has proved disappointing, as its enrichment value is, on an average, not much more than half its illuminating value. The following table gives the increments of light which are to be obtained by the addition of various percentages of acetylene to a low-value coal gas:

Composition of the Mixture.		Illuminating Value.		Enrichment Value of 1 per Cent. in Candles.
Coal Gas.	Acetylene.	Coal Gas.	Mixture.	
99.10	0.90	13	13.9	1.00
97.90	2.10	13	15.1	1.00
96.00	4.00	13	17.3	1.07
95.20	4.80	13	18.4	1.12
91.00	9.00	13	23.5	1.16
89.50	10.50	13	25.3	1.17
85.00	15.00	13	33.0	1.33
83.25	16.75	13	36.1	1.36
66.90	33.10	13	60.5	1.43
55.50	44.50	13	76.7	1.43
16.70	83.30	13	175.2	1.94
00.00	100.00	—	240.0	2.40

This loss of luminosity makes it clear that the great future of acetylene is to be found in its combustion unmixed with other gases for the development of light; and there is no doubt that its future in this direction is a very great one. The ease of its formation from the carbide, and the simplicity of the automatic apparatus necessary for its continuous production, will undoubtedly offer a very great scope for country-house illumination; and for this purpose there is no doubt that, even with the manufacture of the carbide in its infancy, it can be made at a price which will compare very favorably with the illumination obtained from coal gas. For all purposes where portable illumination is required, acetylene will be of the greatest possible value, and the illumination of railway carriages and tram cars offers a wide field for utilizing this magnificent light. In more particular directions, it will prove itself of great value for lighthouses and buoys, for which its ease of compression into the liquid form renders it specially well adapted, as large volumes can in this way be stored in very small space.

I suppose no description of acetylene and its production from calcic carbide would be considered at all satisfactory if I did not say something as to cost—a subject which, I must confess, I should have much preferred to leave alone until figures that could be absolutely guaranteed were available. The data as to cost which have been from time to time supplied from America vary in the most extraordinary way and between extremes which are both equally ridiculous; and the readers of gas literature will have noticed that even as late as last month, in a paper read before the Franklin Institute, it was stated that there was a probability, or at any rate a possibility, of making carbide at about $5 a ton. But this appears to me to be an absolute impossibility, even with the cheapest of cheap water power to generate electricity, and we shall have to look nearer home for data as to the question of cost, if we are to form any idea on this point.

I have information, which I believe to be reliable, to the effect that in Germany the carbide is being made at 170 marks, or practically $42.50 per ton; and experiments carried out in England point to the possibility of making it in bulk at about $47.50 a ton. The figures are strengthened by the consideration that the Swiss Aluminum Company are selling it, packed in hermetically sealed tins, at 6d. per kilogramme, which means $125 a ton; and it is manifest that this could not be done if the cost of production were not about one-third of the selling price. Looking at these facts, I think it will be safe to say that the cost of making it will be between $40 and $60 per ton, and the selling price will be between $50 and $70 per ton; and if this be so, it will, light for light, be a cheaper illumination than coal gas.

A ton of calcic carbide generates 11,000 cubic feet of acetylene; and as this is done locally, where the acetylene has to be consumed, the charge for distribution becomes excessively small. The gas develops 15 times more light than 16-candle coal gas, and therefore, if it costs 15 times as much at the burner, it would be equal in illuminating value to the coal gas. If the carbide cost $95 to $100 per ton delivered, it would only bring the cost per candle to the same as 16-candle coal gas at 63 cents per 1,000 cubic feet, and it is for this reason that I think acetylene has a brilliant future before it.

One of the first things that strikes one on seeing the acetylene flame is the intensity of the light emitted, and after having looked at the flame for a few minutes, one feels that such local intensity cannot be good for the optic nerve. Standing here on Scotch soil, I feel that "discretion is the better part of valor," and that the less I say as to my own particular views as to illumination and the superiority of a cheap low-grade gas over gas of high illuminating value, the better. But I think that everyone will agree with me that, given illuminants of such high intensity as acetylene, and the modern forms of incandescent gas burners, it is necessary to find methods for neutralizing the irritating effect of these high-power lights on our visual organs; and personally I think the introduction of the holopane globes, which give a perfect

distribution and diffusion of the light, and at the same time increase it very considerably for all angles below the horizontal, marks a very important advance in domestic lighting.[1]

Having now given you all the information in my power with regard to acetylene itself, let me try to show you the part which I believe it plays in the luminosity of a hydrocarbon flame; and first of all let me try to demonstrate to you the fact that acetylene is produced in the inner non-luminous zone of the flame. A test by which the presence of acetylene can readily be detected is the property which it has of forming a red acetylide of copper when brought in contact with ammoniacal cuprous chloride solution; and if I introduce the end of a siphon tube into the center of a luminous flame, I can, without much trouble, draw off some of the gas from the center of the flame into a flask which contains the blue cuprous chloride solution. On doing this, and shaking up the flask for a moment, you will see the sides at once coated with the red compound which marks the presence of the acetylene. On repeating the experiment with a candle flame, oil lamp flame, or, indeed, any other luminous hydrocarbon flame, you obtain the same results; showing that, in one and all, acetylene is produced at the top of the non-luminous zone. Quantitative analysis shows that before luminosity commences a very large proportion of the hybrocarbons have been converted into this body.

On looking at the acetylene flame it occurs to one's mind that, to obtain such intense incandescence of the carbon particles as is evidenced by the whiteness and purity of the light emitted, we must have a temperature far in excess of that which gives rise to the yellow light of burning ethylene or coal gas. But on experimenting with the flame itself, one finds nothing to justify this assumption. The flame is, in fact, so cool that one can hold one's hand a few inches above it with perfect comfort; and on testing the temperature existing in various parts of the flame with thermo-couples, one finds that it is not nearly so high as an ordinary coal gas flame or a rich ethylene flame. This experimental fact goes far to shatter one's preconceived idea that the intensity of the light emitted by a luminous flame is dependent upon the heat of the flame.

The next point that occurs to one is that, if the generally accepted theories as to the luminosity of flame are correct, the number of carbon particles in a given area of the flame must exercise great influence upon the amount of light emitted; as increasing the number of particles means adding so many more points of light in a given area. If, however, we examine the molecular composition of acetylene, ethylene and ethane, we find that they all contain the same number of carbon atoms in the molecule, and yet that the illuminating values for equal volumes of gas consumed are 35 for ethane, 68 for ethylene, and 240 for acetylene. Here again it is manifest there is something our present theories do not explain.

It is evident that, if all the hydrocarbons are converted into acetylene before luminosity commences, and if the light is dependent upon liberated carbon particles, or very dense hydrocarbon vapors formed from it, a study of the properties of acetylene is more likely to give us a clue as to the causes of luminosity than any other line of research. When a chemical change takes place it is always accompanied by a physical change, and this generally takes the form of alteration of temperature; and when two bodies combine together to form a third, the alteration of temperature which takes place is generally the evolution of heat. Taking, as an example, the elementary gases hydrogen and oxygen, and causing them to combine, we have the combination of the two to form water—evolving an enormous amount of heat; and for every pound of hydrogen which enters into combination in this way, enough heat is evolved to raise 34,400 pounds of water through 1° C. Accordingly, we say that the heat value of the combination is 34,400 thermal units. There are some cases, however, in which, instead of heat being evolved when a compound is formed, the heat is absorbed—*i. e.*, there is a lowering of temperature; and this makes a very considerable difference in the characteristic behavior of the compound so formed during its decomposition. If water be taken, in order to once more break it up into its constituents, we have to bring to bear upon it as much energy, either as heat or in any other form, as was evolved during the formation of the water; and this is the reason why such enormously high temperatures are needed in order to dissociate water into oxygen and hydrogen. If, however, heat had been absorbed instead of being evolved, the decomposition of the body again renders the heat of its formation available as sensible heat.

Compounds which give out heat during their formation, and absorb the same amount during decomposition, are called exothermic bodies; while others which take in heat during their formation, and therefore decompose with rise of temperature, are called endothermic. This latter class, though not large, comprises in its ranks several well-known hydrocarbons, such as acetylene and ethylene.

There are methods for measuring the temperature of flames, or of solid matter heated in flames, other than such direct thermometric methods as the thermometer and thermo-couple; and foremost among these stands the *lunette pyrométrique*. On measuring the temperature of the carbon particles in the acetylene flame and in the ordinary ethylene and coal gas flames, it is at once manifest that the temperature of the carbon particles is higher than the temperature of the flame itself, or of any substances heated in it—as, indeed, one would expect from the quality of the light emitted; and one is met by the difficulty of explaining how this high temperature of the carbon particles can be produced if the flame in which they are present is at a lower temperature than the heated particles themselves. It is at once evident that the temperature of these particles, which emit the light, is dependent upon circumstances apart from the temperature of the flame itself; and the endothermic nature of acetylene naturally turns one's attention to the possibility of the heat stored up in this body playing an important part in the temperature of the liberated particles.

The great French chemist Berthelot, whose researches have played so important a part in the history of explosives and hydrocarbons during the past century, found, while working out his celebrated theory of explosives, that acetylene could be suddenly decomposed into its constituents carbon and hydrogen by the explosion in it of a small quantity of mercuric fulminate, and that this property of being susceptible to detonation was shared by several other gases and vapors of an endothermic character—*i.e.*, which contained heat stored in themselves.

It seemed to me that if the heat already in the body had anything to do with heating up to incandescence the carbon particles in the flame, one ought to be able to detect this on detonating some of the gas. Having first ascertained the amount of light emitted when a charge of .1 gramme of mercuric fulminate was fired in a close vessel containing air, I filled the vessel with acetylene, and detonated it with a similar charge of fulminate as was used before, and found that its sudden decomposition into carbon and hydrogen gave rise to a most vivid flash of light—the glass vessel in which the experiment was performed being thickly coated with a deposit of carbon from the acetylene, while the small paper case in which the fulminate had been inclosed was only locally scorched and not carbonized in the way one would have expected from the great heat suggested by the intensity of the light emitted. Indeed, when the particles of carbon deposited from the acetylene were carefully removed from the paper, it was found that only at the parts where the fulminate had broken through had any charring taken place.

Here, then, we see that it is possible, by the instantaneous decomposition of acetylene, to generate such intense local heating of the carbon particles liberated from the acetylene as to emit a most vivid light; while the paper gives a proof that this intense heat is so localized in the products of decomposition as to give no time for it to act upon surrounding objects.

Other cases of the same kind occur to one's mind; and, indeed, the ordinary experiment of firing gun-cotton on one's hand or on a heap of powder without igniting the powder or scorching the skin, is a proof that, when rapid action takes place, though one knows that the temperature must be locally very intense, there is no time for the heat to be spread over the surrounding matter. For instance, the heat of the explosion of gun-cotton is known to be 2650° C., or 4802° F.; and yet it cannot impart the 250° necessary to ignite the powder, or, indeed, to yield more than a pleasant glow of warmth to the skin when fired open upon it. It is perfectly manifest, therefore, that the intense local heating during decomposition of the carbon particles in the flame would not of necessity cause an increase of temperature to the flame itself, especially as the temperature recorded by thermometric instruments placed in the flame only gives an average temperatre of a considerable area of the flame, and not the temperature of the molecular particles in which the carbon exists.

A still more simple method of showing the fact that acetylene decomposes into carbon and hydrogen with emission of light, and one less trying to the nerves in the morning than detonation, is to pass acetylene through a fine tube made of hard glass, and to heat 4 or 5 inches of this tube by means of a flat-flame Bunsen burner. It is now possible to obtain glass tubing which will stand for a short period a temperature of nearly 1000° C., and in performing this experiment, we find that as the acetylene enters the heated portion of the tube it decomposes and gives the appearance of a small lurid flame burning in the interior of the tube, while the clouds of carbon liberated by this decomposition

1. The holophane globe was described in our issue of May 18, 1886, p. 690.

flow forward through portions of the tube heated to an even higher temperature than that which brought about the decomposition, but emit no light. I do not think any clearer proof can be adduced that the decomposition of the acetylene will heat the carbon particles to a temperature at which they will emit light.

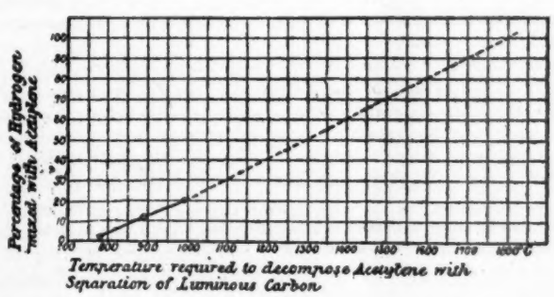
Here, then, I think we have the chief factor in the luminosity of hydrocarbon flames. It by no means follows that the presence of acetylene in the interior of a flame must give rise to a luminous flame, as there are two factors to be satisfied before luminosity is attained. The first is that acetylene, or hydrocarbons capable of being converted into acetylene, should be present; and the second, which is of equal importance, is that the temperature should be sufficiently high to cause the rapid decomposition of the acetylene.

It is perfectly possible for the temperature of a flame to be so little above the point necessary to decompose the diluted acetylene that, while some decomposes and renders the flame faintly luminous, the larger portion burns without decomposition. A good example of this is to be found in the combustion of alcohol, the flame of which contains as much acetylene as is to be found in a good coal-gas flame, but which is practically almost non-luminous. If alcohol in a small dish be ignited, it burns with a faintly luminous flame; and if a bell-jar is placed over it, some of the products of combustion mingling with the flame still further cool it and render it non-luminous. But if a stream of oxygen is introduced under the bell-jar the temperature of the flame is at once increased and becomes highly luminous, while a cold porcelain vessel held in the flame is coated with soot.

The temperature necessary to bring about the conversion of hydrocarbons into acetylene is but little affected by dilution, as it is chiefly radiant heat which is acting; but dilution plays a most important part in increasing the temperature needed to cause the luminous decomposition of the acetylene. This can be clearly shown by the experiment of passing acetylene through a heated glass tube into which a thermo-couple has been fitted, so that the temperature required for bringing about luminous decomposition can be measured. All air having been removed by a current of the mixture to be experimented with, the gas is allowed to pass at a steady rate of flow through the tube, the point at which the thermo-couple is situated being steadily heated by a Fletcher blowpipe, while the temperature recorded on the scale is noted the moment that incandescent liberation of the carbon commences:

Percentage of Composition of Gas.		Temperature Necessary to Cause Decomposition of Carbon with Luminosity.
Acetylene.	Hydrogen.	
100	0	780°C.
90	10	896
80	20	1000

It was found impossible to obtain a glass tube which would stand temperatures higher than this. But on plotting out the points so obtained, and which gave a fairly straight line, it is seen that, even if the increase in temperature only continues for increased dilution in the same ratio as shown in the experimental determinations (which is extremely unlikely) the reason of the destruction of luminosity in highly diluted hydrocarbon gases is at once explained, as an increase of each 10 per cent. in the dilution would necessitate an increase of 100° C. in the temperature of the flame, and with 90 per cent. dilution a temperature of above 1700° C. would be required to bring about decomposition.


Percentage of Hydrogen mixed with Acetylene
Temperature required to decompose Acetylene with Separation of Luminous Carbon

My reason for believing that it is highly improbable that, when dilution is great, it only requires the same increment in temperature to bring about decomposition as when the dilution is small, is that, in all the work I have done on the effects of diluents on luminosity, and also in Professor Frankland's researches upon the same subject, dilution with hydrogen and carbon monoxide acts regularly, and decreases the value of the illuminant in a direct ratio down to about 50 per cent.; while when the degree of dilution exceeds 60 per cent. a rapid falling away in the luminosity takes place—a fact which, I think, points clearly to a regular *pro rata* rise of temperature being needed for increase in dilution up to between 50 and 60 per cent., while higher degrees of dilution need a far greater rise of temperature in order to bring about decomposition.

When a simple hydrocarbon like ethylene or acetylene is burnt alone, the whole of the heat required to bring about decomposition is generated by the combustion, without decomposition, of a considerable proportion of the hydrocarbon. This means very large dilution at the spot where this luminosity commences, so that at the top of the non-luminous zone of an acetylene flame there is only some 14 or 15 per cent. of acetylene present diluted with nitrogen, hydrogen, water vapor and the oxides of carbon.

It is manifest that the luminosity of a flame will be governed, not by the percentage of acetylene in the gas, but at the point at which the temperature is sufficiently high to bring about decomposition. In order to see if the percentage of acetylene present at the top of the non-luminous zone bore any ratio to the illuminating value of the mixture, experiments were made in which mixtures of hydrogen and acetylene were burned at a small flat-flame burner, and the percentage of acetylene was determined by gently aspirating out some of the flame gases from the top of the non-luminous zone:

Analysis of Mixture.		Acetylene at Top of Non-Luminous Zone.	Illuminating Value of Flame for 5 Cubic Feet.
Hydrogen.	Acetylene.		
65.5	34.5	3.72	14.0
43.5	56.5	8.42	87.0
0.0	100.0	14.95	240.0

These results certainly seem to point to the fact that, with flames of the same size burning from the same burner, the light emitted by the flame is directly proportional to the percentage of acetylene present at the top of the non-luminous zone of the flame, provided always that the temperature is sufficiently high to complete its decomposition.

The theory I have tried to develop to you explains many points which the older ideas did not satisfactorily explain. It shows us why dilution with gases incapable of conversion into acetylene renders a gas flame non-luminous; and we also find in it an explanation of why it is that gases—ethane, ethylene and acetylene—though containing the same number of carbon atoms in the molecule, give such widely different illuminating values. It also makes clearer the anomalies which have beset our path in the study of enrichment values. Much has yet to be done before the precise amount of luminosity due to this action is determined. But I am convinced that this phenomenon, and the chemical changes leading to it, will be found to be the chief cause of luminosity in flame.

I have continued the work, and though the experimental details are not yet ready for publication, I find that the main actions going on in a luminous flame may be described as follows: As the gas leaves the burner, those portions which come in contact with the air enter into chemical combination with the oxygen of the air, and give a film of flame in which the hydrocarbons, owing to dilution, are burnt, without any preliminary decomposition, into carbon and hydrogen; the temperature of this film varying according to whether the hydrocarbon is endothermic or exothermic. Acetylene, for instance, gives an intensely hot flame, owing to the heat evolved being the temperature of its combustion *plus* the thermal units due to its endothermicity; while ethane would give a much cooler flame, as so much heat would be absorbed in its decomposition—*i. e.*, much more ethane would be consumed to give a certain temperature than would be the case with acetylene.

When the illuminating gas is a mixture like coal gas, the lighter the constituents are the more rapidly will they diffuse and so reach the outside of the flame. The result of this is that the hydrogen and the methane are the first to burn; and the heavier hydrocarbon, flowing upwards between the walls of flame, become highly heated and converted into a mixture of acetylene and methane.

Taking ethylene as the type of the unsaturated hydrocarbons present in the gas, the change would be represented by—

Ethylene.		Acetylene.		Methane.
$3C_2H_4$	=	$2C_2H_2$	+	$2CH_4$

and at the top of the inner non-luminous zone, 80 per cent. of the unsaturated hydrocarbons present are found to be acetylene. The temperature of the flame rapidly rises the higher the point; and at the spot where the luminosity of the flame commences, the temperature is upwards of 1,000° C. This causes sudden and extremely rapid decomposition of the acetylene into its constituents—

Acetylene. Hydrogen. Carbon.
$$C_2H_2 = H_2 + C_2.$$

The heat thus liberated, having no time to dissipate itself among the other gases present, heats up the carbon particles to a temperature far higher than the avarage temperature of the flame—causing them to become incandescent, and so render the flame luminous; the incandescence of these solid particles being further aided by the temperature of the flame and by their own combustion, partly by the oxygen of the air and partly by the action of water vapor and carbon dioxide upon them—

Carbon. Oxygen. Carbon Monoxide.
$$(a)\quad C + O = CO.$$

Carbon. Water Vapor. Carbon Monoxide. Hydrogen.
$$(b)\quad C + H_2O = CO + H_2.$$

Carbon. Carbon Dioxide. Carbon Monoxide.
$$(c)\quad C + CO_2 = 2CO.$$

It is the combustion of the carbon monoxide and hydrogen so formed which gives the upper portion of the outer non-luminous envelope to the flame. The small blue portion of the outer envelope at the base of the flame is caused by the rapid inrush of air—the nitrogen so diluting the hydrocarbon molecules at that point that they are burnt up without being first decomposed. There being, therefore, no separation of carbon, there is no luminosity. The same blue color may be observed when a gas flame is rendered non-luminous by dilution either with nitrogen or carbon dioxide.

Beyond this point we cannot at present go, but I hope the considerations I have brought before you this morning will awaken new lines of thought in your minds, and that even if you are not at present willing to adopt the theory that I have tried to make clear to you, you will not condemn it until those gentlemen who profess antagonism to it have some feasible experimental evidence to offer against it.

[Concluded from p. 10.]

Engineering Fallacies.

[By President Henry Morton, Ph.D., in the *Stevens Indicator*.]

What I have written above shows that the "doctrine of conservation of energy" is one calling for "missionary effort," even in the scientific circle surrounding such an instructor as *The Engineer;* and, stepping down to a lower level, I find another call for enlightenment in one of our most prominent daily journals.

Thus, on the editorial page of the New York *Sun*, March 27th, is a letter signed Geo. H. Peabody, and headed "Keely Heard from Again," in which is announced the speedy exhibition of a "250-horse power commercial engine." The chief evidence adduced in this letter in support of the above claims is a quotation from the late Dr. Leidy, justly celebrated as one of the first anatomists and surgeons of the world, which reads as follows: "Mr. Keely's discoveries would astonish the scientific world, and the great worth of them could not be estimated."

That Dr. Leidy made such a statement, I have no doubt whatever, nor that he stood at the head of his procession; but, that he was competent to investigate such a subject as the Keely motor tricks, is quite another matter.

Having some personal acquaintance with Dr. Leidy, I know him to have been a man of perfect candor, and of a trustfulness of disposition which led him to accept any statement made to him as presumably correct; and to go on believing, even when he saw that what he had been told might possibly be untrue.

This is strikingly illustrated by a correspondence I had with him on the very subject of the Keely motor, as I will now relate. In October, 1889, at the request of some friends, I had agreed to attend an exhibition of the Keely motor, but, at the last moment, was prevented from doing so.

A neighbor, however, who was a firm believer in Mr. Keely, went to the "seance," and the next day reported to me in a vivid manner all that was done, relating, also, that Dr. Leidy was present and had expressed surprise and conviction.

So clear was the account of my friend, that I felt certain I could judge from his description how the operation was carried out, and I therefore wrote to Dr. Leidy, explaining my solution, and asking him a series of questions calculated to bring out any objections to my theory.

He replied, admitting that my explanation was consistent with everything he had seen, but expressing the wish that I would come on and see for myself these "wonderful experiments." In other words, the Doctor, while realizing that the effects *might* be produced by a trick, could not believe that deceit had been employed, and that Mr. Keely was anything else than the honest investigator he pretended to be.

This use, or abuse, of the reputation of men distinguished in some very different line of studies, which, in many cases, directly unfits them for the investigation of such fallacies, is a very common device, of which another example has come to my notice within a few days. In my previous article, I related the incidents of a visit to the workshop in Newark where Mr. Paine was exhibiting a perpetual motion electric motor. A few days since a letter from Mr. Paine appeared in a local daily, in which he denies the fact of my visit, and proceeds to substantiate the value of his invention by reciting the names of a number of distinguished men, all now dead, who took a financial interest in its development. (See note.) It so happens that I knew nearly all these gentlemen at the time referred to, and most that I said outside of my own observations was communicated to me by them. While, however, in questions of finance, politics, military affairs, details of mechanical manufacture and philanthropy, I would gladly sit at their feet as a learner, there was not one of them whom I would trust to detect manipulations such as were involved in Mr. Paine's exhibitions.

A general, a governor, a millionaire, a constructor of small machines, and even the most benevolent and public-spirited of manufacturers, were far more likely (as in this case was actually proved) to be lambs easily shorn by a clever adventurer than competent detectives able to expose his methods.

This is in fact one of the pitfalls that the young engineer needs to be warned of, and to avoid, namely, the risk of being led to accept a statement as true because it is credited and perhaps indorsed by some one prominent in business, or who is before the public (with good cause) for eminent achievements in some special field. The liability to be misled on unfamiliar subjects existing in high places is simply incredible, if the evidence were not overwhelming. For example, some few years ago I was called on to give testimony in a case which grew out of the circumstance that a gentleman of the highest standing in his community and the business head of a great chemical works, had allowed himself to be persuaded, by means of fraudulent experiments, that, by a

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NOTE.—In kindness to Mr. Paine, I will assume that the question he has raised as to the fact of my visit and what I saw in the building in which his electro-magnetic engine was exhibited is one of memory rather than veracity, and, in this view, it is easily settled by reference to a letter published about the time of my visit by Prof. Henry A. Rowland, C.E., now of Johns-Hopkins University, Baltimore, Md., and which appeared in the *Scientific American* for 1871, Vol. 25, p. 21.

In this letter Prof. Rowland relates how, on applying for admission, about 12 o'clock, he was told that the machine was not running then; but that returning after 1 o'clock, he was admitted and taken up to the second floor of a brick building, where he found the inventor, some of his friends, and his machine; also, that the machine was enveloped in a cast iron case, giving it the general appearance of a fan blower, and was seemingly operated by a battery, with a great development of energy.

Prof. Rowland then continues as follows: "The exhibition being over, on going down-stairs, in company with the rest, I tried the door of the room below, but found it locked, and the windows covered with papers. I desired to get in, but was met with the assurance that the room was rented by a man who was then absent.

"This, I believe, is the last visit paid by an outsider to this wonderful invention. I have been there several times since, but there has been no admittance to me or to anyone else. I have since been to the owner of the building, and find that Mr. Paine rents the room to which I sought admittance, and also rents power in that same room, which is directly below that containing his machine. The engine from which the power comes generally stops work at 12 and starts again at 1, but sometimes works all day.

"My visits there have established the following facts: First, that my friend and I were denied admittance at 12 o'clock, but were invited to come at 1. Second, that the shaft in the room below does not revo've between the hours of 12 and 1. Third, that the room below, containing power, was rented by Mr. Paine, but that he kept it carefully locked, and misguided me as to the tenant. Fourth, that the working parts are concealed in an unnecessarily strong case, well adapted to the concealment of another source of power."

This is followed by much more to the same effect, but enough has been quoted to show that it is not *my* memory which was at fault when I related what I had seen at the time of my visit shortly before this one made by Prof. Rowland. That Mr. Paine should have forgotten the fact that, after declining his invitation in the morning, I nevertheless accepted in the afternoon, after my lecture preparations were completed, is entirely natural.

As to the substantial accuracy of my memory about the collapse of Mr. Paine's company, the following brief quotation will, I think suffice:

Scientific American, 1872, Vol. 26, p. 321. "The *Telegrapher* states that the Paine Electro-Magnetic Engine Company bubble, late of Newark, N. J., has gone up, that the inventor has left for the East, where the wise men came from, and that the stockholders have experienced a galvanic shock in the shape of a total loss of their interests."

certain hocus-pocus process, a pound of ammonium sulphate could be made to yield twice the quantity of ammonia which it contained.

The fraud, in this case, consisted (as was shown during the trial) in packing a quantity of the ammonia salt, out of sight, in the generating vessel, before the arrival of the gentlemen in whose presence the "*experiment*" was conducted. Curiously enough, the suit above referred to was brought by the representatives of the swindlers, to compel the confiding victim to pay some $40,000 for stock in a company which was to be formed for the development of the "*invention*." Thanks to an array of learned counsel and an intelligent jury, the complainant was not successful; but I should be sorry to have to pay the expenses incurred by the successful litigant, to say nothing of the $5,000 cash he had given as "earnest" to the "promoters."

The fact is that for the investigation of such "inventions" a peculiar detective talent and experience are required; and, in all cases, it is prudent to have nothing to do with such schemes unless the entire conduct of the experiment is placed in the hands of the investigator. A demand for this will generally relieve anyone from the importunities of "promoters" and "inventors" of this class.

Testing Prepared Tar.

[By Herr C. Lunge, in the *Journal fuer Gasbelenchtung*, and translated for the *Am. Manufacturer*.]

Prepared tar products are mixtures of coal tar pitch with distillates of coal tar in varying proportions. After the volatile products have been distilled from the tar, the hard pitch remaining in the still is difficult to remove, and its use, in the hard state, is very limited. It may, however, be utilized by adding to the still fluid pitch some of the heavy oils, which are of little value for other purposes. According to the quantity and quality of the oils so added, semi-hard or soft pitch, asphalt, varnish for iron, or "prepared tar" can be produced. The latter term was probably at first applied to a preparation for roofing felt, etc., its advantages being that, the volatile constituents having been removed, it was free from smell and not liable to crack in drying. For both the manufacturer and user it is a great advantage for the benzol, phenol, naphthaline and anthracine to be removed without decreasing the usefulness of the prepared tar, especially as, by regulating the quantity of oil added, any required consistency can be obtained. As under the term "prepared tar" many various compounds may be understood, it is desirable, in order to avoid disputes between the manufacturer and purchaser, to define what in each case the composition should be.

In a case in which the author had to give a professional opinion it appeared that this was not defined, and the following proceedings are now proposed:

Three samples of prepared tar, of German and Polish origin, were obtained, and these will be referred to as samples *A*, *B* and *C*.

In making such tests, the use to which the tar is to be applied should be borne in mind, and the test should also be simple and rapid. Many of the properties of the tar, such as the quickness in drying, covering capacity, resistance to weather, etc., cannot be easily determined in laboratory experiments, but they at least admit of the uniform composition of different deliveries being ascertained, and of their agreement with a normal sample. As an easy and accurate mode of testing, three points should be determined, namely, the specific gravity, the viscosity and the quantity of volatile matter. For the determination of the specific gravity, it is proposed to use a specific gravity tube, with a glass stopper having a small groove filed in the side; the tube is filled with the tar to be tested and the stopper inserted, so as to force the superfluous tar through the groove; after weighing, the tar is poured out, and the vessel is cleaned by wiping out with blotting paper and a little oil. Thick tar frequently contains air bubbles, which can only be separated by continued heating. The operation may also be effected by partially filling the tube with tar and weighing. Let (*a*) represent the weight of the empty tube, (*b*) its weight filled with water at 59° F., (*c*) the weight filled to about ⅓ its height with tar, and (*d*) the weight when the remainder of the tube is filled with water. The tube, with the stopper removed, is stood for an hour in hot water until all the air bubbles are expelled and weighed after cooling. The required specific gravity of the tar will then be equal to:

$$\frac{c - a}{b + c - (a + d)}.$$

By this means the specific gravity of the tar, sample *A* was found to be 1.1649 at 64.4° F., of sample *B*, 1.1972 at 73.4° F., and sample *C*, 1.2424 at 68° F.

With prepared tar, the viscosity is in many cases of much importance; this cannot be cetermined in the manner usually adopted for oils, etc., and a specially designed hydrometer was used for the purpose, the rate at which the instrument sank in the tar to a fixed point being taken as a measure of the viscosity. The instrument differs from ordinary hydrometers in being made of very stout glass; the body is cylindrical, with a semi-spherical lower end; it is about 4 inches long and 0.8 inch external diameter, and is surmounted by a stem 8.9 inches long and 0.3 inch diameter. On this, 0.6 inch above the conical neck, the specific gravity of 1.400 is marked, and the specific gravity figures are continued upwards to 1.050, which occupies altogether a length of 7.5 inches, the most important part of the scale, up to 1.250, being at a distance of about 3.2 inches from the neck. The instrument is weighted with shot, held in place by sealing wax, and it weighs about 600 grains.

The tar to be tested is put in a cylindrical vessel to such a height that, when the tester is inserted, the vessel is nearly full; the tar is then well mixed and the temperature determined, the cylinder is then stood in cold water until the tar reaches a temperature of 59° F. The tester is then inserted up to the mark 1.250, withdrawn and allowed to drain. A seconds watch is then taken in one hand and the tester in the other. The latter being held so that its lower end touches the surface of the tar, and it is let go when the seconds hand reaches zero. The tester sinks rapidly until the contracted portion is reached, and then goes much slower; when the mark 1.250 is reached the time is observed, the instrument is then taken out and allowed to drain for two or three minutes, after which a second observation is taken. Three or more observations should be made and they should agree to within two or three seconds. The point 1.250 is sufficiently below the specific gravity of a normal prepared tar, so that the hydrometer sinks very slowly at last, and it is found that small differences in the weights of the testers do not materially affect the results. With tar *A*, at a temperature of 59° F., the sinking of the instrument varied in time between 34 and 37 seconds, and at 76° F. the time was from 10 to 12 seconds. With tar *B* at 59° F. the time occupied was from 69 to 72 seconds, at 72° F. 40 to 41 seconds, and at 74.3° F. 32 to 33 seconds. Tar *C* was barely fluid at ordinary temperatures and could not be satisfactorily tested in this manner, as at 74.3° F. the instrument took several hours to sink to the 1.250 point.

With regard to the volatile constituents, it would probably be sufficient to stipulate that a prepared tar, at a given temperature, should yield a certain quantity of distillates; but there are many practical difficulties in determining this; the boiling points of some of the constituents are above that of mercury, and any thermometer, even if made of hardened blass, would become incorrect with use.

A preferable plan is to distill 100 grams in a hard glass tubular retort over an open flame, until a determined quantity of the volatile compounds has passed over; the specific gravity of the distillate is then determined, and, after cooling, the retort is broken and the specific gravity and softening point of the pitch ascertained. If the first trial does not yield a normally hard pitch, another test is made, the distillation being continued for a longer or shorter time, as the conditions of the first trial indicate to be necessary. A second, or, at the most, a third test will give the required result.

The following examples illustrate the operation: From 100 grams of tar *A* 50.2 cubic centimeters (3 cubic inches) of oil were distilled of 0.063 specific gravity, or 53.4 per cent. by weight of the tar; the specific gravity of the pitch being 1.2938 at 73.4° F., the pitch having a dull luster and would not soften in water at 208° F., which proved it to be hard pitch. In a second trial 44 cubic centimeters (2.68 cubic inches) of oil, of specific gravity 1.040, or 45.7 per cent. by weight, were distilled off. The specific gravity of the pitch was 1.2852 at 68° F., and it was difficult to knead at 163° to 167° F.; at 184° F. it was quite soft, and it melted at 208° F., showing it to be somewhat too hard. In a third trial 40 cubic centimeters of oil were distilled off, the specific gravity being 1.041, or equal to 41.6 per cent. by weight of the tar. The remaining pitch had a specific gravity of 1.2704 at 73.4° F.; it was difficult to knead at 122° F., and very soft at 140° F., and was therefore somewhat below medium hard. From this it is concluded that this prepared tar contains about 43.5 per cent. by weight of oil and 56.5 per cent. of fairly hard pitch. Similar particulars are given for tars *B* and *C*.

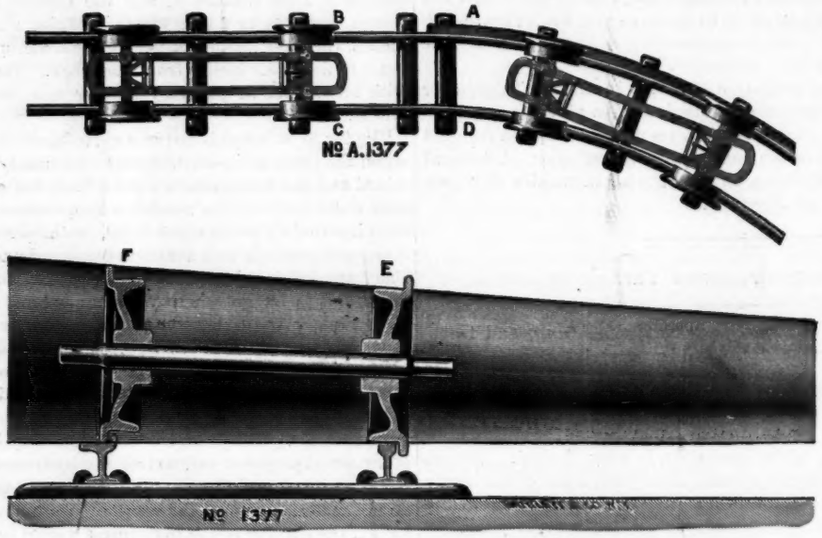
From such tests certain definite conditions may be fixed for estimating the quality of the prepared tar, such as the specific gravity, the viscosity and the quantity of volatile compounds. In most cases three tests will be found unnecessary, as the specific gravity and the viscosity will suffice for determining the value.

The Hunt System of Narrow Gauge Railways for Manufacturing Establishments.

The fact that narrow gauge railways for handling and transferring coal, castings, parts of machinery, and materials of all kinds in and around manufacturing establishments play a very important part respecting economy in the operation of a plant, is daily more fully appreciated, especially in a plant of considerable magnitude or where the various departments are in separate buildings.

A system of cars and tracks is as much a "machine" as a lathe, a steam hammer or a loom, and should be judged in the same way. The saving in time and labor assured by its introduction, the increased efficiencies of other machines, or of the whole works, at once effected, the greater protection against damage afforded material being handled or moved, and the general convenience must be balanced against the interest on the investment and the expense of maintenance.

In putting in a railway of this kind many questions arise which require careful consideration, such as, "What gauge is the best for this purpose?" "What radius curves should be used?" "How heavy should the rail be?" "What style of cars will be best?" "What kind of cross ties should be used?" "How shall the switches and crossings be made?" "Can turntables be avoided?" "What will be the effect of grades," etc., until it looks as though one would have to abandon his regular business to decide these details. There is, however, no necessity of doing this, if one determines at the outset to put in a thoroughly tried and reliable system, leaving as far as possible the entire matter, with all vexatious details, to the experience and expert judgment of the builders.



Figs. 1 and 2.—Hunt System of Narrow Gauge Railways for Manufacturing Establishments.

The Hunt system of narrow gauge railways for industrial establishments is in this counection worthy of notice. These industrial railways are built by the well-known C. W. Hunt Company, 45 Broadway, New York, who have for many years given the subject careful consideration, and have acquired an excellent reputation as builders of high grade machinery of this class.

In determining the gauge and the radius of the curves most suitable for an industrial railway, it is necessary to take into consideration all of the circumstances under which it is to be used. The C. W. Hunt Company believe that if the gauge adopted by them (21½ inches, measured from the outside to the outside of the heads of the rails) is not the ideal one, it comes very near to being so. In all of the railways that they have built they have never had a user even suggest that a broader gauge would be better for any purpose.

In a manufacturing establishment the curves should be of so short a radius that every part of a factory can be reached directly without expensive and troublesome turntables. The Hunt Company state: "Our standard curves are 12 feet radius, measured to the center of the tracks. This radius is almost exclusively followed in manufacturing establishments where cars are usually moved by hand, because cars can be employed with a running gear which runs as easily on a curve of 12 feet radius as on a straight line, the axles taking a radial position with the outer wheel running on the flange, instead of on the tread, thus enabling workmen to move double the load they could with ordinary cars. It is for this reason that we build our railways with outside flanged wheels. These variations from ordinary railway practice make no difference whatever in the operation of the general construction, except that the curves, switches and frogs must be especially arranged to suit wheels with outside flanges."

The load which can be carried on a railway depends not upon the gauge but upon the strength of the track, consequently whatever strength is needed to carry a certain load can be obtained with a narrow gauge as readily as with the standard 4 feet 8½ inch gauge.

The Hunt cars, which are of improved construction, are fitted with a flexible wheel base,

Fig. 3.—Special Charging Car, Arranged to Tip, built for G. H. Gilbert Manufacturing Company, Gilbertville, Mass.

Fig. 4.—Special Coal Charging Car for Gas Generators of the Northern Gas Light Company, New York City.

Fig. 5.—Special Self Dumping Car with Narrow Body, Built for the Equitable Gas Light Company, Foot of 44th Street, New York.

the axles taking a radial position on a curve, the wheels and the curve being so proportioned that there is no slipping whatever to cause friction. This departure from the old style rigid base cars is an important feature of the Hunt system, and its advantage will be at once appreciated by anyone who has had experience with rigid wheel base cars. The principle on which the cars turn a curve is illustrated in Figs. 1 and 2. A cylinder rolls on a plane in a straight line without sliding friction; a cone rolls on a plane in a circle about its vortex without sliding friction. If both of the wheels of a car running on a curve have the same diameter as the cone would have each rail, they are portions of the cone, and the wheels would run around the curve without sliding friction, the axles taking a radial position. The illustration, Fig. 2, clearly shows that, if correctly made, there will be no sliding friction in passing the curve. In applying these principles the outer rail around the curve is made of a special form so that the wheel runs on a flange instead of on a tread. The axle bearings are pivoted in the center, between the wheels, permitting them to take a radial position as the wheels direct.

Could the wheels be made absolutely round and exactly to the theoretical diameter, and the tracks perfectly smooth and laid to an exact circle, the cars would then pass around a curve as easily as on a straight track. Although it is impossible in commercial machinery to fully realize theoretical conditions, the difference between the running gear as furnished by the C. W. Hunt Company and the ideal ones is slight.

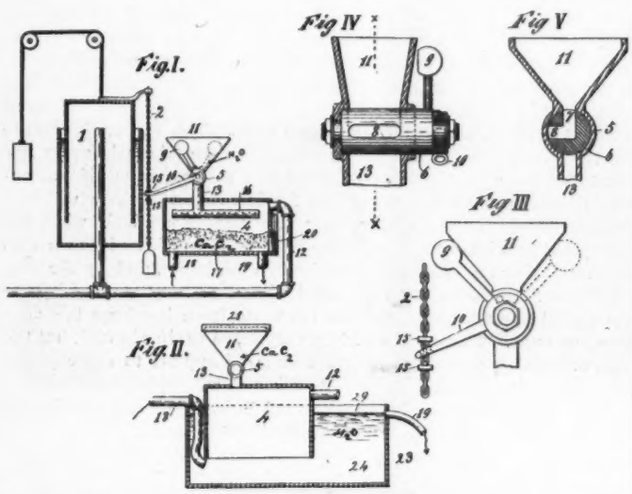
Rigid wheel base cars do not run easily around a curve because one of a pair of wheels of the same diameter secured rigidly to the axle must slide on the rails a distance equal to the difference in the length of the inner and the outer rail. In a car having two pairs of wheels, with the axle boxes rigidly connected to the frames, not only must this sliding take place, but it is increased by the unfavorable position in which the axle holds the wheels, as the axles cannot take a radial position, which is the one most favorable. Beside the standard cars illustrated in their latest catalogue, No. 9,504, the C. W. Hunt Company are prepared to furnish cars of special design for carrying all kinds of material, and in this system of narrow gauge railways offer apparatus embracing in its construction all the latest improvements in machinery of this class.

Dickerson's Process and Apparatus for the Production of Acetylene Gas from Calcium Carbide.

On June 25th U. S. Letters Patent (No. 541,526) were granted to Mr. Edward N. Dickerson for an "Improvement in Process of an Apparatus for the Manufacture of Combustible Gas." Using the words of the specification :

This invention relates to an improvement in processes of and apparatus for the manufacture of combustible gas produced by bringing together two combining materials, which by their chemical action produce the resulting gas, and is especially applicable to the production of acetylene gas by bringing together calcium carbide and water.

The apparatus is arranged to feed the water to the calcium carbide or the calcium carbide to the water intermittently, as such feeding may be necessary to supply the gas consumed, and in order to accomplish this result I operate said feeding devices by a governor which causes the operation of such feeding devices intermittently as the gas is consumed. As shown, a governing holder is provided which receives the excess of



gas due to the feeding in of the gas producing material. It would be disadvantageous in devices of this kind to connect the feeding device, say the water feeder intended to spray the water upon the calcium carbide, directly with the governor in such way as that the water cock might stand open, because the generation of gas is not instantaneous, and an excess of water beyond the capacity of the holder might be fed into the carbide before the governor operated. By my device I propose, therefore, to feed in only so much water as will not fill the holder to its capacity, and no other charge can be fed to the holder until the holder has become emptied to the desired point. The operation both of feeding the water to the carbide and of feeding the carbide to the water is substantially the same in principle. By my device, also, I provide for removing the products of decomposition of the carbide, principally lime, without stopping the operation of the machine.

The invention will be readily understood from the accompanying drawings, in which Figure I. represents a vertical elevation, mostly in cross-section ; Fig. II., a modification of the generating chamber, showing a different method of removing the refuse ; Fig. III., an end elevation of the feeding-in valve ; Fig. IV., an elevation of the same at right angles to Fig. III., mostly in sections ; Fig. V., a section through Fig. IV., on the line x x. In the drawings similar numbers refer to similar parts.

I will first describe the operation of the apparatus with reference to Figs. I., III., IV. and V.

1 represents the governing gasholder of any suitable construction ; 4, the generating chamber ; 11, hopper or water supply connected with the generating chamber by pipe 13 and spraying device 16 ; 12, pipe connecting generating chamber with gasholder ; 5, tumble-bob stopcock intermittently operating and alternately communicating with the hopper 11 and generator 4 ; 10, arm for operating the tumble-bob stopcock ; 2, chain connected with the gasholder and operating the arm 10.

In the operation, as shown in Figs. I., III., IV. and V., the water is designed to be fed upon a body of calcium carbide 17, in generator 4. The feeding-in cock 5 is provided with plug 6, having therein an angular channel 7, 8. This cock is operated through a right angle by any well-known form of tumble-bob contrivance, controlled by governing holder 1. In the position shown in Fig. V., the gasholder has risen and thrown the tumble-bob weight 9 to the position shown in dotted lines in Fig. I. At this point, therefore, a charge of water fills the chamber 7, 8 of the cock. This chamber may be made oblong, as shown in Fig. IV., to increase its capacity, if desired. In the position shown in full lines in Figs. I. and III., the channel 8 is connected with the delivery pipe 13, and the charge of water has been delivered to the carbide, the entry of the water to the cock being of course shut off by the revolution of the cock. When the water is delivered gas is generated from the carbide 17, in generator 4, thereby raising the gasholder 1, which enables the plug 6 of cock 5 to receive an additional charge of water which is retained in the cock until the holder has again descended to the position shown in Fig. I., when it is delivered upon the carbide. The amount of water which the cock will contain is not sufficient when entirely converted into gas to produce gas in excess of the capacity of the holder, and as no additional water can be received in the holder until after the holder has again been discharged, the apparatus is entirely safe from any over production of gas. When the carbide 17 is used up it may be discharged by door 20, or preferably washed out by water pipe 18 through delivery pipe 19. The various pipes in this apparatus are, of course, provided with suitable stopcocks to open and close them as desired. A subsequent charge of carbide is then placed in the generator 4 and the operation recommences.

In Fig. II., the same device is shown as in Fig. I., excepting that in this case it is intended to feed the carbide to the water. In this case, of course, it is necessary that the carbide shall be reduced to a powdered condition. It is then placed in the hopper 11, which may be provided with cover 21 to prevent accidental escape of gas. In this case the bottom of the hopper 4 is open and is sufficiently below the level of the water 22, to furnish the pressure necessary to deliver to the gasholder 1 through pipe 12. The generated gas rises through the water and the lime settles to the bottom of the water receiver 23, whence it can be continuously removed by a flow of water through pipe 18, which water escapes through the overflow 19. The lime itself will mostly settle in the part 24 of the water chamber 23, whence it can be removed as desired, without stopping the operation of the device.

The inventor's claims are :

1. The process of producing illuminating gas without the addition of heat, which consists in intermittently bringing in contact with each other a determined quantity of a liquid or a solid, which, by their union, produce a fixed gas, the said intermittent additions producing determined quantities of gas, substantially as described.

2. The process of producing illuminating gas without the addition of heat, which consists in intermittently bringing in contact with each other a determined quantity of a liquid or a solid, which, by their union, produce a fixed gas, the said intermittent additions producing determined quantities of gas, and of determining the frequency of said production of determined amounts of gas by the consumption of the gas, substantially as described.

3. The combination of the gasholder 1, the valve 5 having a chamber therein of determined capacity, and a connection between the holder and the said valve for operating the same, the said valve having a chamber of fixed capacity alternately connecting with the feed and the delivery, thereby at each operation feeding the measured contents of the chamber into the gas generating chamber 4, substantially as described.

4. The combination of the gasholder 1, operating a feeding-in valve containing a chamber alternately connecting with the feed and delivery of the apparatus, and delivering the contents of the chamber at each operation, of the generating chamber 4 connected therewith, located in the water chamber 23 having its open bottom at a sufficient distance above the bottom of the chamber 23 to allow of the withdrawal of the material fed through chamber 4 by the valve 5, and means for withdrawing said material, substantially as described.

Coal Storage Plants of the Philadelphia and Reading Railroad.

At the June meeting of the Engineers' Club, of Philadelphia, a paper on the subject named in the heading was read by Mr. William D. Beatty. The author said: In order to provide for the demands of the coal trade, it has been found necessary to store coal in large quantities in order to be ready for emergencies. The mines, as a rule, work only part of a week, and the further possibility of strikes, flooding of the collieries, blockades, and various other causes, make it necessary to have a large supply on hand to meet the demands which may be made.

There are two general methods of coal storage, first the Hillside system, generally situated in the mining regions, and second, what may be termed the Level Floor system, generally located at or near the shipping points.

In the Hillside system large bins are constructed on the slope of a hill, and a dumping track led along the top of the slope. The coal is dropped from the cars on the dumping track and rolls down the hill till stopped by the front of the bins. From the front of the bins a series of plank run back horizontally till they strike the slope of the hill, thus helping to arrest the coal and forming the beginning of the coal pile.

It is generally reloaded by an underground chain conveyer. This conveyer runs along the whole front of the storage plant, and is operated by a rope drive. The coal is led into the conveyer trough by men with short lengths of sheet iron, and the conveyer thus carries it to a central hopper. Here another conveyer picks it up and carries it up an inclined plane to a tower, where it is screened and loaded into cars. Both the Schuylkill Haven and the Mahanoy City plants of the Reading Company are operated on this system.

The Schuylkill Haven plant was first operated by dump cars running back into the coal piles and then forward to a reloader track on a wharf constructed at the foot of the slope. From the edge of the wharf the coal was dropped through a screen and chute into the cars. This system is still used at Schuylkill Haven in connection with the later one.

The second, or Level Floor system, is well illustrated by the present plant at Port Richmond, Philadelphia, and the new plant now being constructed there on the Dodge coal storage system. The latter occupies about 15 acres in the neighborhood of the present coal piers, and will consist of six piles of coal, two of 20,000 tons each, two of 30,000 tons each, and two of 40,000 tons each, making a storage capacity of 180,000 tons.

In this system the coal is stored by a chain conveyer, carried by a braced truss, constituting a trimming machine or trimmer. The apparatus for reloading consists of a pivoted ground conveyer with a flighted chain, an inclined plane carrying troughs for lifting the coal, and a tower for screening and delivering to the cars. Generally in this system two trimmers and one reloader constitute a group, but in this case the two groups are each composed of three trimmers and two reloaders. There are thus six trimmers and four reloaders, with inclines and screening towers, used in the operation of this plant.

The trimmers span the coal piles at an angle of 27°, which is about the natural angle for coal in large quantities. The diameters of the coal piles are 232.4, 265.4 and 291.4 feet, and their altitudes are respectively 59.2, 67.7 and 74.4 feet.

The coal to be stored is run in on the dump track and dropped into a hopper. The hopper pit consists of a steel tank embedded in brick masonry and encloses the lower end of the conveyer trough. Above this, timber joists and planking lined with sheet iron form the hopper. Through a small door in the hopper, controlled by an outside lever, the coal drops into the conveyer trough, where it is picked up by the flights on the chain and carried to its position in the pile. This position is determined by a sliding sheet 12 inches wide, which winds on a drum at the foot of the trimmer, and forms the bottom of the conveyer trough. This sheet is worked by hand gearing, and its upper end is thus made to follow the receding apex of the coal pile, continually feeding the pile from the apex, and further allowing the coal to drop but a few inches. The conveyer chain having deposited its coal, runs onto a sprocket wheel at the head of the trimmer, then back along the top on guide angles supported by steel frames bolted to the trimmer, to another tower at the foot, whence it runs vertically to the hopper pit and up the trimmer again.

When the coal is wanted for shipment, the reloader is moved to the edge of the coal pile and the chain set in motion. The flights on the chain then pick up the coal and carry it up the incline to chutes leading to shaking screens in the tower, where it is screened and loaded into the cars. By means of a screw and lever the shaft on the reloader carrying the head sprocket wheel may be moved forward or back, thus keeping the chain always at the proper tension.

The conveyer chain travels on the wearing plate to the foot of the incline, then up one side of the incline in a trough to a sprocket wheel on the head shaft in the screening tower, thence down the other inclined trough and around the other side of the reloader to the starting point. This conveyer chain is continuous over both reloader and incline, thus saving one dump with its consequent chance of breakage. It is guided by horizontal wheels at the short end of the reloader, and by holding down wheels at the point of junction of the horizontal and incline, thus keeping the flights in direct contact with the coal. On both the trimmer and the reloader there is a guard over the chain, which serves still further to prevent the flights mounting the coal at any point.

Two wire ropes pass over spools on a hollow vertical shaft at this point and run back under the incline, one to the lever controlling the reloading drums, and the other to the lever controlling the chain movement. The man stationed on the platform thus has absolute control of the reloader, and is in the best position for directing its movements.

The screens are of the shaking type and are double, the top one separating the sizes, the lower one taking out the dirt. The mesh of the top screens in the different towers varies according to the size of coal handled, but the screens themselves may be changed in a short time. They are suspended by wrought iron links and are worked by eccentrics on a shaft connected by chain belting with the main shaft in such a way that the oscillation of the screens takes place whenever the reloader chain is working; the top screen leads directly to the long chute, and coal passing over the screen is loaded into cars on the first track. Cars on both tracks can therefore be loaded at the same time.

The power plant, operated by four independent Buckeye engines of 100-horse power each, was then described.

The other conveyer systems of the Philadelphia and Reading Railroad at Fairmount avenue and Ninth street station, Philadelphia, were also briefly described, and the author closed by stating that the new plant has a nominal capacity of three tons a minute; but the experience of similar plants has been that, including delays from breakdowns, stoppage to get out the dust, delay in shifting, and the usual troubles that occur in any large plant, 1,000 to 1,400 tons lifted, and the same amount dumped, constitute a fair day's work. The higher figures are for the later plants constructed on this system, and there is every reason to believe that the Richmond plant will at least equal, if not exceed those figures; but, even taking the low estimate, there will be a large saving in the cost of handling over present methods when the new plant goes into operation. Besides that, it furnishes its own car-haul, reducing the locomotive service to a minimum, and by the continuity of the reloading system, and by having a very small drop for the coal at transfer points, reduces the waste from breakage to a very small amount. There will also be a very large saving in fuel, but the plan of burning screenings may of course be applied to other power plants as well, and is not essential to this system.

Figuring on past records of cost, and allowing a fair estimate for the working capacity of a plant, it is expected that a saving of $35,000 or $40,000 a year in the cost of handling will result from the operations of the new plant.

Test of a Cahall Boiler Using Blast Furnace Gas.

The *Iron Age* says that the Pittsburgh Testing Laboratory has just made a report on a 10-hour test made on May 10 on a Cahall boiler, at the blast furnace of the Salem Iron Company, Leetonia, Ohio, using blast furnace gas.

The boiler tested was a direct fired Cahall water tube boiler, having 108 4-inch tubes 22 feet long, and 2,500 square feet of heating surface. The diameter of the steam drum is 80 inches, the height 80 inches; the diameter of the smoke flue 34 inches; the diameter of the mud drum 68 inches, height 48 inches; height of the smokestack 50 feet, diameter 38 inches; dimensions of grate 3 feet 6 inches by 6 feet, consisting of 14 sections 3 feet by 6 inches, having 1¼ by ¼ air space and ¼-inch metal; grate surface 21 square feet; rated by the makers as 250-horse power.

The height of furnace stack is 76 feet; the diameter of downcomer 6 feet. The flue coming from the downcomer, besides supplying the boiler tested, furnished gas for four stoves, one battery of three boilers, and one of eight boilers, all of the two-flue type. Dimensions of the main gas flue are 4 feet by 6 feet. The boiler tested was at the end of this flue, and therefore the pressure and quantity of gas were much less than at the other boilers. Capacity of the blast furnace is approximately 200 tons per day, four casts being made every 24 hours, during which

the gas is off for a period of 10 or 15 minutes. The steam generated supplies three blowing engines and several pumps.

The blast furnace gas was fed through two burners, with an area each at the outlet of 80 square inches, or a total of 168 square inches. These two burners were located one on each side of the fire door. The coal used as a lighter to the gas was Cherry Valley bituminous slack. The following are the analyses of the gas used, two samples being taken during the test:

	No. 1.	No. 2.
Carbon dioxide	10.10 per cent.	9.70 per cent.
Oxygen	2.00 "	2.40 "
Carbon monoxide	24.40 "	26.02 "
Hydrogen	2.10 "	.36 "
Nitrogen	61.40 "	61.52 "
B.T.U. per cu. ft. at 32° F.	90.50 "	90.02 "

The analysis of the coal used was as follows:

Carbon	72.09 per cent.
Hydrogen	4.26 "
Sulphur	1.40 "
Nitrogen and Oxygen	11.26 "
Ash	9.76 "
Moisture	1.23 "
B.T.U. 13,276 per pound of coal	100.00 "

The following is an analysis of the gas at the downcomer:

Carbon dioxide	11.50 per cent.
Oxygen	.40 "
Carbon monoxide	27.90 "
Hydrogen	1.66 "
Nitrogen	58.54 "
B.T.U. per cubic foot gas at 32° F	100.92 "

The average temperature of the gas at the downcomer was 574.3° F. and at the burner 454.7° F. Theoretically one pound of coal is equivalent to 283.10 cubic feet of gas at 454.7° F. as used or referred to 30° F. 147.08 cubic feet. Therefore, 566,200 cubic feet of gas at 454.7° F. as used is equivalent to a ton of coal, or referred to 32° 294,160 cubic feet of gas equals one ton of the above coal. Natural gas in the vicinity of Pittsburgh varies from 30,000 to 40,000 cubic feet as equivalent to one ton of coal. One will thus see that this gas is of exceedingly low efficiency.

The water used was measured in two supply barrels, each being filled until the telltale ceased to drip, when these barrels were emptied into a third or suction barrel, from which it was fed into the boiler by a small Snow duplex steam pump. The weight of each of these supply barrels was carefully ascertained by filling and weighing both before and after the test. The pump was connected to the blow-off in the bottom of the outside circulating pipe, and had rather a tendency to feed the boiler against the circulation. As there were not proper facilities and connections in order to feed with the circulation, it was decided not to disconnect the regular feed to do so. Just before the time of starting the test the water was shut off from the regular feed by two globe valves, and the check valve opened in order to make sure that no water went into the boiler other than by the pump. The total amount of water evaporated was 81,647 pounds, average temperature of feed 198° F. At the start of the test the height of the water in the waterglass was measured, and a red band placed around it. At the close of the test the water was brought to this height and marked. The water used was the hot feed-water which regularly supplies the other batteries of boilers, being drawn from the main feed pipe run from the heater, a large open heater being used.

The temperature of the escaping gases in the stack was determined by a nearly new pyrometer made by Oelschlaeger Bros., New York. This pyrometer was placed about 2 inches above the swing of the damper. The average temperature of escaping gases was 504.5. The damper in the stack was left open or nearly open during the whole test, which showed that the tubes take nearly all the heat, which they should, from the burning gases. Two samples of gas were taken from the stack during the test, about four hours apart, which show a fair combustion. Following are analyses of the same:

	No. 1.	No. 2.
Carbon dioxide	20.56 per cent.	19.46 per cent.
Oxygen	5.10 "	5.30 "
Carbon monoxide	0.34 "	0.14 "
Hydrogen	none "	none "
Nitrogen	74.00 "	75.00 "
B.T.U. per cu. ft. at 32° F.	1.16 "	0.478 "

The steam pressure was fairly constant, averaging 96.3 pounds. The safety valves were loaded at 100 pounds.

The calorimeter used was a throttling calorimeter manufactured by the Crosby Valve and Gauge Company. Calorimeter tests were made with sufficient frequency to determine the quality of the steam; 0.40 of 1 per cent. moisture was found.

Observations were taken every 15 minutes during the 10 hours, and the average of these was used in the results obtained.

The results of this test in the main are very satisfactory, as low temperatures in the stack were obtained and the small amount of less than 38 pounds of slack per hour was used, and yet the boiler exceeded its rated capacity. While the excess was not very marked the conditions under which the boiler made this excess over the rated capacity were such as to reflect great credit on the boiler. This boiler is one of a battery of two Cahall boilers. As stated before, this boiler is located at the end of the flue coming from the downcomer, and the pressure and amount of gas are not sufficient to supply these two boilers with enough to develop a high percentage over their rated capacity. These two Cahalls generate so much steam that the Salem Iron Company now have an abundance of steam, which they never had in the past. For this reason the boilers were not forced. If this boiler were situated in the place of some of the other antiquated ones now running it would, without doubt, run very much over its rated capacity. One point to be noticed is that this boiler developed power from blast furnace gas only, as the amount of slack fired was merely to keep the grate covered and to furnish a lighter for the gas. The manner in which the gas burned, expanded in the combustion chamber, passing around and through the tubes with great force, was most satisfactory, and is borne out by the low temperature and the analyses of the gases in the stack. From watching the action of the burning gases through the cleaning doors we can say without hesitancy that the manner of burning the gases in the combustion chamber before it reaches the tubes is a most excellent one. We think the high evaporation obtained exceedingly satisfactory and the performance of this boiler in every way most creditable. The results are summarized as follows:

Grate surface, square feet	21
Heating surface, square feet	2,500
Duration of test, hours	10
Duration of test, actual hours	9.6
Cubic feet of gas, total, at 454.7° F	1,987,738
Cubic feet of gas per hour, at 454.7° F	207,056
Cubic feet of gas, total, at 32° F	1,632,673
Cubic feet of gas per hour, at 32° F	107,570
Pounds of coal fired, total	387.5
Pounds of coal fired per hour	37.85
Ash, total pounds	38
Equivalent coal by analysis of gas, total pounds	7,023
Equivalent coal by analysis of gas, per hour pounds	731.6
Area of gas burner, total sq. in	160
Average temperature of gas at burners 252.6°C.	454.7° F.
Average pressure of gas at burners, ins. water.	0.30
Average pressure of gas at downcomer, 301.3°C.	574.3° F.
Average pressure of gas at downcomer, in water	1
Average steam pressure, pounds	96.30
Average barometer 28.88, pounds	14.14
Average absolute pressure, pounds	110.44
Average draft pressure inches of water, inch	0.45
Average temperature of feed water	198.0° F.
Average temperature of outside air	85.9° F.
Average temperature of escaping gases in stack	504.5° F.
Quality of steam (moisture per cent)	0.40
Pounds of water evaporated, actual conditions	81,647
Pounds of water evaporated, actual conditions per hour	8,504.9
Pounds of water evaporated, actual conditions per 1,000 cubic feet of gas at 454. 7° F	41.1
Pounds of water evaporated from and at 212° F., per 1,000 cubic feet of gas at 454.7° F	43.25
Pounds of water evaporated, actual conditions per pound of fuel by analysis, equivalent of gas plus actual coal	11.05
Pounds of water evaporated from and at 212° F. per pound of fuel by analysis, equivalent of gas plus actual coal	11.63
Pounds of water evaporated from and at 212° F. per pound of combustible by analysis, equivalent of gas plus combustible of coal	12.92
Pounds of water evaporated per hour per square foot heating surface	3.40
Pounds of combustible per horse power per hr.	2.67
Horse power, actual condition	283.5
Horse power, from and at 212° F	298.4
Horse power rated	250
Percentage above rated capacity, actual conditions, per cent	11.2

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE Honesdale (Pa.) Company is making many main extensions this season, the principal addition being a pipe to North Park, in which suburb the Company will secure several good-paying consumers.

THE projectors of the Gas Company for Hammond, Ind., have made an amended proposal to the Council for the franchise under which they propose to operate. In the new application the Company agrees to supply gas for illuminating purposes at $1.50 per 1,000 cubic feet, less 25 cents per 1,000 for prompt payment, and to supply gas for fuel purposes at 90 cents per 1,000, less 10 cents per 1,000 for prompt payment. The Company is to have in operation 2 miles of main pipe within 18 months from the dating of the passage of the ordinance, otherwise the latter shall be void. The life of the franchise is put at 25 years.

THE authorities of Spring Lake, N. J., have agreed to permit the Consolidated Gas Company, of New Jersey, to lay its gas mains within the borough limits.

THE Appleton (Wis.) Gas Company will, we understand, add a coal gas plant to its present water gas system, with a view to distributing a mixed gas in the future. The outlook at Appleton is very encouraging.

THE new business structure, now being erected by the Indianapolis (Ind.) Gas Company, on South Pennsylvania avenue, Indianapolis, will be the finest office building in the State. It is to be completed by December 31st, 1895, and the cost thereof, apart from the site, will be not far from $360,000.

THE Lighting Committee of the Camden (N. J.) City Council has agreed to the proposition submitted by the Camden Gas Light Company for the public lighting of the city by gas. The Company's figures were: Ordinary street lanterns, equipped with 6-foot burners, $19.75 each per annum; single Welsbach burners, $22.50 per annum each; double Welsbachs, $25 each. We do not know how many lamps of the Welsbach type are to be installed, although it is understood that several of the single and double order will be tried. The lighting schedule, of course, is on the basis of every night and all night.

THE following is the text of the veto by Governor Altgeld, of Illinois, of the measure known as the "frontage bill:" "I hereby veto House bill No. 801, entitled 'An Act to regulate the granting of rights and special privileges for lighting purposes by cities, villages and incorporated towns.' This bill provides that City Councils or other municipal authorities shall have no power to grant a franchise to lay gas pipe and to lay or string electric light wires on or in a street, except upon a petition signed by the owners of a majority of the frontage of each mile of such street. A careful examination of this bill and a thorough inquiry as to the conditions as they exist in the cities of this State, especially the larger cities, in relation to franchises for furnishing gas and electric light to the public, have satisfied me that while the provisions of this bill are not at first view so directly calculated to create a monopoly, as were the provisions of House bill No. 618, which was recently vetoed, still its practical effect would be the same. It will under this bill be in the power of every existing gas company or electric light company in large cities to entirely prevent any new company from getting a franchise. All that would be necessary would be to foil the new company in getting the signatures of a majority of the frontage in any one mile of the entire street. The ordinances now held by the gas companies of the State are general in character, authorizing the company to put in pipes on any street in the city, and the question naturally arises, Why should prospective competitors be subjected to a different rule? Surely long-continued possession by a private corporation of some space in a street ought not to give it exclusive control of such street. If the City Council originally had power to authorize the first company to put in pipes, it should have power to authorize a competing company to do so. It is to be noted that in no instance has the public asked for the passage of this bill. The Chicago Gas Companies labored for its passage. It is claimed that the municipal authorities in some cities make it a practice to grant franchises to new gas companies, and that the old companies are compelled to buy out the new companies, or, what amounts to the same thing, are obliged to submit to being blackmailed in order to prevent the municipal authorities from granting ordinances to new companies. It is claimed that the old companies should be relieved of this kind of extortion. In answer to this it is only necessary to say that the old company does not need to buy up the new franchises given to competing companies if it does not want to, and it does not need to give blackmail to anybody. If the new ordinance is granted to people who do not in good faith propose to make and sell gas, then it will not hurt the old company. The right thing for the old company to do in such a case is to pay no attention to the new ordinance. Whenever a new ordinance is granted to people who in good faith intend to make and sell gas, why, let the new company go on and enter into competition with the old. The fact is that buying up ordinances granted to new companies the old company simply manages to hold a monopoly. It is true that the public derives no benefit from this operation, but the gas company, being in the wrong and responsible, the wrong cannot be heard to raise that objection. There is, however, a principle that lies deeper than this. Some way should be devised to protect the public, and in that connection to protect the old companies. In some States they have a Board which has the power to fix the price of gas in every town in the State. Had we such a tribunal in this State, then the objection to fostering a monopoly would at least in part be removed. In Massachusetts this Board not only fixes the price of gas, but it passes upon applications for new franchises, so that it fills the double office of protecting established interests on the one hand from blackmail and of protecting the public from extortion on the other. If suitable measures for the protection of the public can be placed upon our statute books, then I should have no hesitation in approving the principle which is involved in some of the measures I have recently been obliged to veto, for we cannot shut our eyes to the fact that in many fields competition has entirely died out and no longer furnishes protection to the public. This is an age of concentration and consolidation, and this principle is so universal that all of our anti-trust laws and decisions, our laws against combination and monopoly, seem to have accomplished but little. We have been trying to kick back the waters with our feet and have not been successful. The new order of things has come to stay and there is an advantage in it, taken by itself—it does cheapen production. The difficulty has been so far that instead of having the public get the benefit of this advantage, it is in many cases not only monopolized by a few individuals, but these individuals are enabled, by reason of this combination and concentration, to wield a power that is injurious to the public and which tends toward the destruction of republican institutions. I, therefore, repeat that the time seems to have come when wise statesmanship requires that we should recognize existing conditions and permit men to make these great combinations legally, and at the same time not only secure the public protection, but insure to it some of the benefits that arise from combination; but until this is done the State cannot abandon the policy which all governments have pursued for centuries."

THE Santa Ana (Cal.) Gas and Electric Light Company will extend its service to the adjoining borough of Orange.

THE Hartford (Conn.) City Gas Light Company has declared its regular semi-annual dividend of 4 per cent.

ON June 25th application was made in the United States Circuit Court, by Mr. E. W. Andrews, of Seattle, Wash., for a receiver for the Racine (Wis.) Gas Company. Petitioner alleges that fraudulent practices have been discovered on the part of the Company's present management.

THE Connecticut Legislature has passed the measure incorporating the Thames Gas Company, which proposes to operate in opposition to the New London (Conn.) Gas Company.

ONE of the really handsome pamphlets issued by a Gas Company for the purpose of increasing the popularity of gas cookers is that put out by Superintendent F. H. Parker, of the Burlington (Vt.) Gas Light Company. Its pages contain 11 illustrations of kitchen interiors, showing how the kitchens appear when the cooking apparatus thereof is heated by gas fuel. The pamphlet also gives many reasons why gas fuel in the kitchen should be used in preference to any other.

IT is freely asserted in Pawtucket, R. I., that the Council will refuse to grant the Pawtucket Gas and Electric Lighting Company the 20-year exclusive franchise asked for by the latter. The provisions of the franchise were printed in the JOURNAL some weeks ago.

AT a recent meeting of the East Boston (Mass.) Council the following resolution, offered by Mr. Barnes, was adopted:

"*Ordered*, That the Mayor be requested to take such action as shall be necessary toward securing for the residents of East Boston the privilege of having illuminating gas furnished them at a cost not exceeding $1 per 1,000."

THE Old Colony Railroad has paid the Jamaica Plain (Mass.) Gas Light Company the sum of $27,500 for realty owned by the latter on Keyes street, which was damaged by the Railroad Company during the process of changing its grade on the Providence division.

THE Athol Gas and Electric Light Company is adding to its electric generating apparatus, with a view to furnishing power to the local trolley system.

"E. P. C.," writing to the JOURNAL from Spokane, Wash., under date of June 27th, says: * * * "Spokane is improving, and the Gas Company is 'all right.' Although the Company has had a considerable increase in the number of consumers, as compared with the number on the books a year or so ago, the gas output is still below that of the comparison period. This shrinkage per capita is undoubtedly due to the extreme care and economy exercised by the residents during the last 18 months. The Welsbach light is helping the Company out greatly against the competition of the electric light, even though the latter is produced by *cheap* water power. The Welsbach lamps placed have replaced ordinary gas burners, say, 33⅓ per cent., 20 per cent. can probably be credited to former users of oils and new gas consumers, and the balance is to be credited to displacement of arc and incandescent lamps. The gas rate here is $2.50 per 1,000 cubic feet, with 10 per cent. off if bills are settled at the Company's office on or before the tenth of the month. Coal costs a trifle under $6 per ton of 2,000 pounds, and it yields about 9,000 cubic feet of gas and 1,200 pounds of good coke—the latter readily sells for about $7 per net ton. The coal most in favor comes from the Roslyn collieries, which lie on the eastern slope of the Cascade Mountains, on the line of the Northern Pacific Railroad, and the haul to Spokane amounts to about 300 miles. The candle power of gas from Roslyn coal (when the yield is 4½ feet to the pound) is 16 candles, which is increased to 18 candles before it reaches the consumer by the carbonization of a small percentrge of a coal known as Cle-elum coal—a sort of cannel mined on the eastern slope of the Cascade Mountains at a point some 100 miles from the Roslyn vein. Oxide purification prevails exclusively, The holder capacity consists of one 30,000 cubic foot vessel (the first one built), and a second holder of 110,000 cubic feet, constructed about two years ago. The Company has 7 miles of mains, on which are about 800 consumers. I enclose a circular now being sent out by the Company to the public, which will be of interest. Upon the completion of the new plant, mills, etc., of the Washington Water Power Company, the local electric lighting company will have a competitor, but the Gas Company does not fear the outcome—even with electric light at half rates, as now supplied by the present electric company in competition with gas—since it relies on the potent aid of the Welsbach lamps, and the constantly increasing popularitv of gas for cooking, heating and power purposes."

THE circular referred to by our correspondent is as follows:

"OFFICE OF SPOKANE FALLS GAS LIGHT CO.,
"S 13 Post street.

"No one more fully appreciates the comfort and convenience of gas. both for lighting and as fuel for cooking, than the housekeeper who, because of the increased price of oil or unsatisfactory electric light, makes the change. This Company is impressed with the fact that hundreds would appreciate this were they placed in a position to do so; but hitherto the expense of piping the house and purchasing fixtures has prevented those from using gas who would otherwise. To all so situated this Company has the following proposition to place before them: We will lay a service pipe to building line and furnish meter and connections free of charge; from building line through soil to meter at a charge of 10 cents per foot; also, will run pipe through any house at a charge of 7 cents per foot; also, supply ordinary fixtures and cooking range—or small portable stove and oven, which can be placed on a table or other convenient stand—at a monthly rental of 75 cents. This includes rent of fixtures and stove and cost of setting same. To those desiring it we will supply the Welsbach burner, with its beautiful light of 60-candle power, at a use of 3 cubic feet of gas per hour; or, in other words, one Welsbach burner will brilliantly light a room 16 feet square at a cost of 7-10ths of a cent per hour for each hour of burning. Considered merely as a labor saver and a time saver, the gas cooker is priceless in its value to the housekeeper. A turn of the stopcock and a touch of the match and the fire is ready, hot and steady, with no delays, no dirt, no fuss of coal and kindling. As many are not familiar with the cost of gas piping, we illustrate below an approximate cost of piping houses of different sizes and the terms of payment as per this offer:

Service pipe, 15 ft., at 10 cts.		$1 50	$1 50	$1 50	$1 50	$1 50
1. House piping, 2 rooms..		2 45	.....	.....	.....	.....
2. " 3 " ..		....	3 30	.....	.....	.....
3. " 4 " ..		....	.....	4 10	.....	.....
4. " 5 " ..		....	.....	.....	4 90	.....
5. " 6 " ..		....	.....	.....	.....	5 80
		$3 95	$4 80	$5 60	$6 40	$7 30

Concealed work. Four monthly payments (each): 1st, $1; 2d, $1.20; 3d, $1.40; 4th, $1.60; 5th, $1.85. A gas cooking stove and plain piping fixtures may be rented for 75 cents per month. As we anticipate numerous responses to the above generous offer, applications will be filed and work proceeded with in the order received.—W. A. ALDRICH, Secretary."

THE following is an official copy of the text of the decision of the Massachusetts Board of Gas and Electric Light Commissioners, in respect of the petition for a revision of the gas rates from certain residents of Brockton, Mass.:

"COMMONWEALTH OF MASSACHUSETTS IN
"BOARD OF GAS AND ELECTRIC LIGHT COMMISSIONERS,
"BOSTON, June 24, 1895.

"This was a petition by customers of the Brockton Gas Light Company for improvement in the quality and a reduction in the price of gas supplied by that Company. A public hearing was given in Brockton, at which the parties in interest were represented by counsel. There was but little criticism at the hearing of the quality of the gas, and no facts were presented with sufficient definiteness to support a charge of inferiority in any respect. The gas of this Company has for a long time been much above the standard of candle power required by statute, and when the representatives of the petitioners were informed that this fact appeared from the report of the State Inspector, they did not further press this portion of their complaint. The principal contention of the petitioners seemed to be with respect to the price. The Company was organized in 1859 as the North Bridgewater Gas Light Company, the present city of Brockton being at that time the town of North Bridgewater. It began to supply gas in that year and has been throughout its history the only Company authorized to supply gas within the city limits. Since March, 1893, the capital of this Company has been represented by stock to the amount of $178,500, and bonds to the amount of $100,000, upon all of which 6 per cent. is now paid. From 1881 to 1889 its stock was $64,000; and from 1883 to 1889 its bonds were $35,000. In 1885 the Company executed a lease of its works for a term of 20 years, from which the lessee agreed to pay in return, above all taxes and other charges, 7 per cent. upon the stock and 6 per cent. upon the bonds. On Oct. 11, 1889, the control of the corporation passed into the hands of the lessee and his associates, by a transfer of the majority of the stock, and an entirely new Board of Directors was elected, of which the lessee was a member. Three days later it was voted to pay the lessee $36,000 for improvements and extensions to the works made by him. Two days later it was voted to cancel and surrender the lease, and on the following day to pay the lessee $50,000 additional for its surrender. By the terms of the lease it was provided that upon its termination 'the value to the lessor at that time of all improvements made by the lessees shall be ascertained by three arbitrators, and the amount thereof paid by the lessor to the lessee, each party to choose one arbitrator and the third to be selected by the other two.' The Board has been unable to find in either the records, accounts or files of the Company any allusion to such arbitration; and diligent inquiry of persons in position to be familiar with the facts fails to furnish any evidence that such arbitration took place. No substantial and expensive improvements were made at the station during the lease, and a sworn return of main extensions show that but a small portion of the amount named could have been invested in that direction. It would also appear, from the returns filed in this office, that the lease, for the cancellation of which the sum named was paid, has not been profitable to the lessee. The $36,000 was procured from the sale of new stock at par which was bought by the lessee; $35,000 for the surrender of the lease was obtained from a new issue of bonds still outstanding, and the balance in promissory notes, which are represented in the present floating debt. Early in the following year the control of the corporation passed into the hands of new parties, residents of Brockton. In April, 1892, the control again changed, more than half the stock being bought by the present owners, the representatives of the American Light and Fuel Company, a corporation chartered under the laws of the State of New Jersey. The object of the corporation seems to be in part to control and operate gas works and to procure and dispose of the right to certain potential processes for

(*Continued on page* 54.)

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(*Continued from page* 53.)

the manufacture of gas. Directors and officers of the New Jersey Company soon after became Directors and officers of the Brockton Company, and at once proceeded to expend about $10,000 in the erection of a plant for the manufacture of gas under the patents of the New Jersey Company. This plant was completed in September, and in the following month it was voted to pay the parent Company $79,000 for the right to manufacture under its patents in the city of Brockton. The cost of the plant is represented in the present debt of the Company, and, to pay for the patent rights, new stock was issued to the amount of $78,500. The new plant was put in operation September 30, 1892, and was run until February 15, 1894, when it was abandoned as a failure. The process was never a success in Brockton or anywhere else. In the face of all the facts recited, it becomes perhaps unnecessary in the present case to comment upon the management during the periods named, or to in any way characterize the existing stock. Neither the corporation as such, nor its customers, possess to-day or ever have received more than a minimum of benefit from the issue of the securities described. Consumers have a right to demand that profits in corporations of this character shall come from the legitimate exercise of their charter powers and not from speculative manipulation of their stock, even though under the forms of law. The burdens of reckless management belong to the corporation and not to the public. In former decisions the Board has held that the profits of companies supplying this kind of service must compare favorably with those which a new company might need to pay a fair dividend when fully equipped to render the same service. There seems to be ample reason for applying the same principle in the present case. A new corporation could construct its works and be fully equipped to supply the public demand for gas without any issue of securities for the purposes described above. In view of all the facts to which reference has been made, the Board recommends that, on and after the 1st day of July next, the net price charged for gas supplied by the Brockton Gas Light Company shall not exceed $1.50 per 1,000 feet. For the Board—FORREST E. BARKER, Chairman."

On receipt of an official rescript of this decision, the Brockton Company filed with the Board its acceptance thereof.

The Market for Gas Securities.

There was no change of moment in the market for city gas shares last week, and stagnation characterized the dealings. Consolidated claimed little or no attention, and the buying or selling orders in it were few and far between. The opening quotations to-day (Friday) were 143¼ bid, offered at 143½, but these are merely nominal, as a *bona fide* order to purchase 500 shares "at the market" would likely send the rate to 148, whereas an order of the same sort to sell would likely break the rate to 140. Equitable is offered at 197, ex-dividend of 3 per cent., and Standard preferred is offered at 106, ex-dividend of 1½ per cent. New York and East River specialties are neglected, but the bid price for the common holds fairly strong, at 30, which is but 1½ points behind the demands of holders.

In Brooklyn the situation, as we predicted would be the case, is somewhat mixed over the application to the Board of Alderman for a franchise for the Mutual Gas and Electric Company, the projectors of which signify their willingness to sell gas at $1 per 1,000 cubic feet, and to pay to the city an annual cash bonus as well. There are none so blind as those who wilfully keep their eyes closed, and we again say that the Equity ghost ought to be laid by those who have the power to enshroud it "for keeps." The out-of-town feature was the continued weakness in Chicago gas, which sold below 59 since last time of writing, although to-day's opening quotations were 61 to 61½. The sum and substance of the situation there seems to be that the people now in control are not of the strongest sort—in fact, we have heard them referred to as amateurs. Amateurs or professionals as they may be respectively considered, the stock looks to be cheap. Lacledes are weak and seemingly well out of favor, Baltimore Consolidated shows no appreciable change, and Consumers, of Jersey City, is 89 bid. In respect of the latter, we repeat our belief that it ought to reach par before the Christmas holidays. Bay States are dumpy, and Western gas is still in demand at anything under 65.

Gas Stocks.

Quotations by Close & Nash, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

JULY 8.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	143¼	143¾
Central	500,000	50	140	..
" Scrip	220,000	..	100	..
Equitable	4,000,000	100	194	197x
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	112	..
Metropolitan Bonds	988,000	..	108	112
Mutual	3,500,000	100	170	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	
Northern	150,000	50	90	91
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	30	31½
Preferred	2,000,000	100	55	57
Bonds	3,500,000	1,000	94¾	95¾
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	..	..	..
Standard	5,000,000	100	66	68
Preferred	5,000,000	100	105	108x
Bonds, 1st Mortgage, 5's	1,500,000	..	106	..
Yonkers	.....	50	101x	.
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	125	..
Citizens	1,200,000	20	65	..
" S. F. Bonds	330,000	1,000	..	101
Equity	2,000,000	10	..	..
" Bonds	1,000,000	..	..	..
Fulton-Municipal	3,000,000	100	175	..
" Bonds	300,000	..	103	..
Peoples	1,000,000	10	90	..
" Bonds, 7's	368,000	..	100	..
" " 6's	94,000	..	98	100
Metropolitan	870,000	100	170	..
" Bonds, 5's	70,000	..	..	..
Nassau	1,000,000	25	225	..
" Ctfs.	700,000	1,000	99	100
Williamsburgh	1,000,000	50	210	..
" Bonds	1,000,000	..	107	110
Out-of-Town Companies.				
Bay State	5,000,000	50	17	17¾
" Income Bonds	2,000,000	1,000	23	27
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	78	80
2d " " "	3,000,000	1,000	52	53¾
Buffalo Mutual	750,000	100	120	..
" Bonds	300,000	1,000	95	100
Chicago Gas Co.	25,000,000	100	61	61½
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	93	93½
Columbus	1,000,000	..	..	..
1st Mortgage	1,085,000	..	..	..
Consumers. Jersey City	2,000,000	100	89	..
" Bonds	600,000	1,000	101	..
Cincinnati G. & C. Co.	7,000,000	100	203¼	203½
Consumers, Toronto	1,600,000	50	184½	187
Central, San Francisco	.....	..	90	100
Capital, Sacramento	.....	..	..	80
Consolidated, Baltimore	11,000,000	100	62¾	63¼
Mortgage, 6's	3,000,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	29	..
" Con. Bonds	4,312,000	..	60	70
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	74	75
" Bonds	2,000,000	..	84	86
Hartford	750,000	25	120	128
Indianapolis	2,000,000	..	153x	..
" Bonds, 6's	2,650,000	..	106	..
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	84	86
Bonds	1,000,000	1,000	86	88
Louisville	2,570,000	50	..	130
Laclede, St. Louis	7,500,000	100	25	25½
Preferred	2,500,000	100	80	85
Bonds	9,084,400	1,000	95	95½
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	..
New Haven	.....	25	225	..
Northwestern Ohio Nat. Gas	.....	..	48	..
Oakland, Cal.	.....	..	42½	43
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	83	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	73¾	73¾
St. Paul Gas Light Co.	1,500,000	100	68	70
1st Mortgage, 6's	650,000	..	..	..
Extension, 6's	600,000	..	.	..
General Mortgage, 5's	2,400,000	..	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	64½	..
Bonds, 5's	3,556,000	..	92¾	..
Wilmington, Del.	500,000	50	188	190

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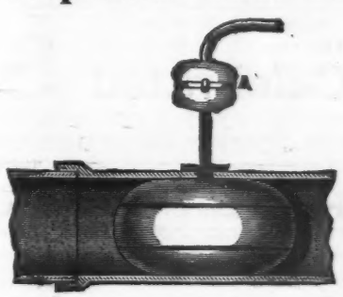

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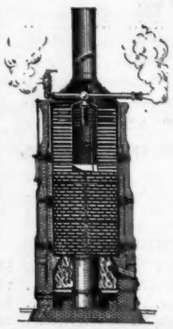

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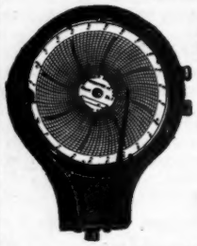

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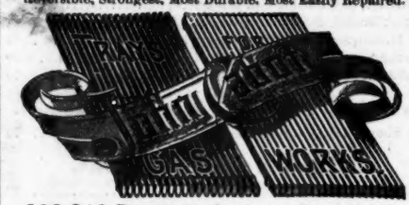

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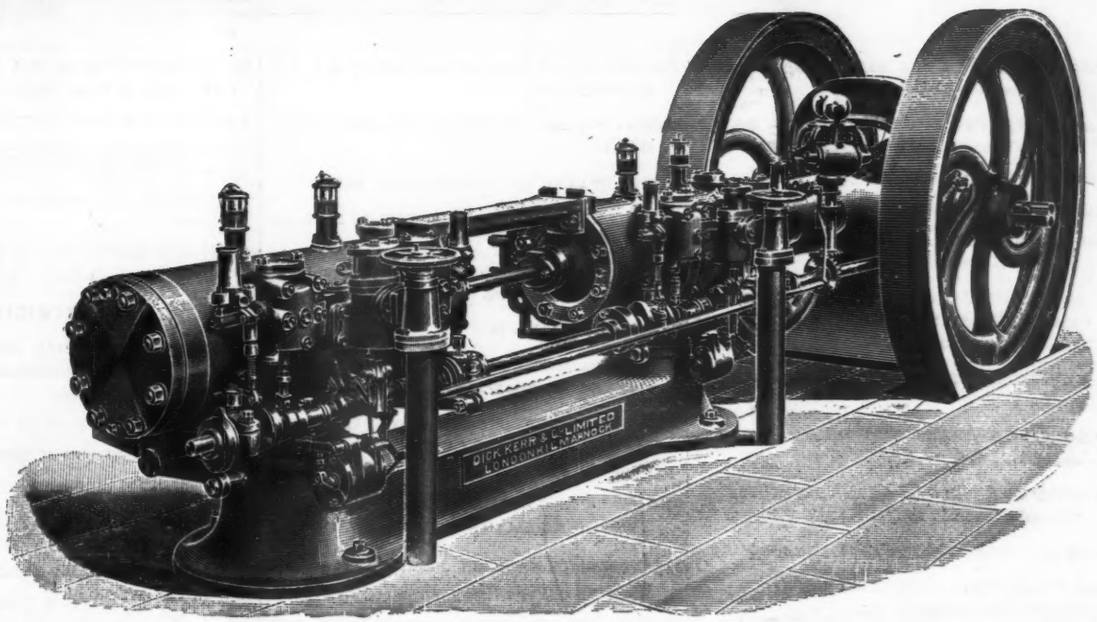

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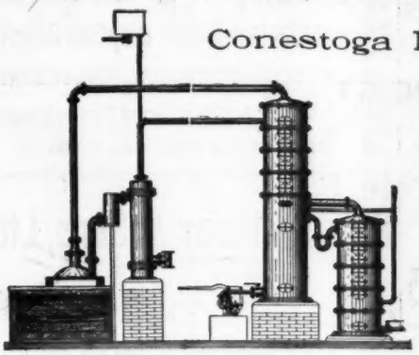

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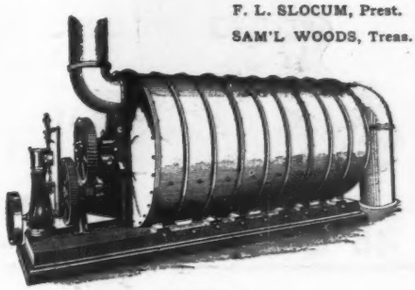

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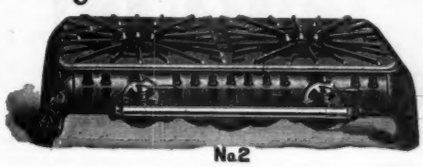

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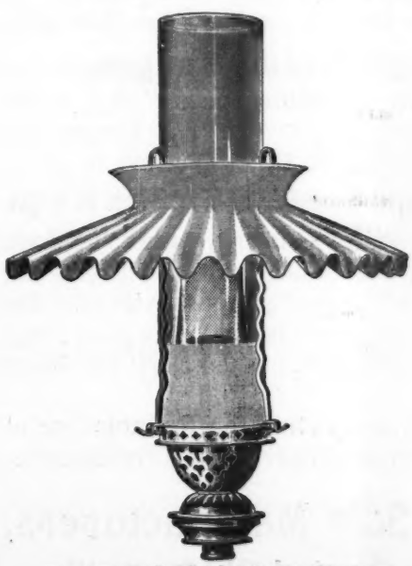

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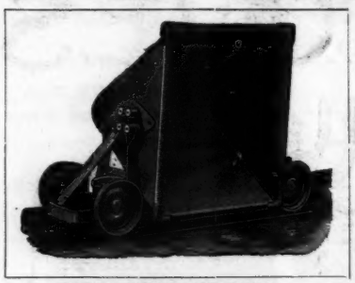

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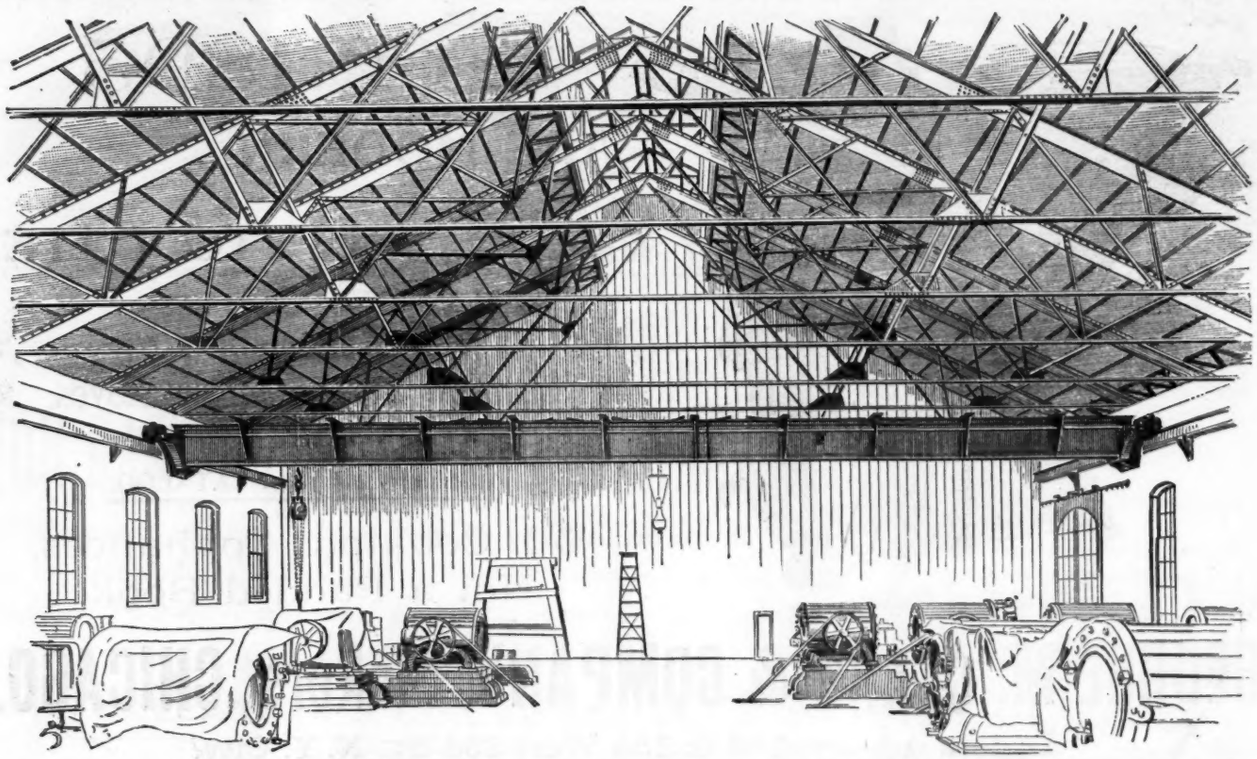

The above illustration, taken direct from a photograph, shows the construction of an Iron Truss Roof, with a Traveling Crane, both of which were designed and built by us for the Narragansett Electric Lighting Company, at Providence, R. I. The illustration is taken in the Dynamo Room, which is 60 feet in width by 200 feet in length. The side walls are of brick, with iron roof trusses covered with our Patent Anti-Condensation Corrugated Iron. This is the first roof ever built with this Patent Anti-Condensation Corrugated Iron, and after passing through three severe winters has shown no signs whatever of any dripping or sweating on the Corrugated Iron. We guarantee this Anti-Condensation Iron Roof Covering not to drip in the coldest weather.

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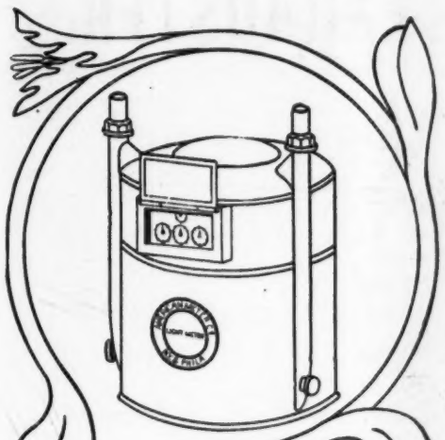

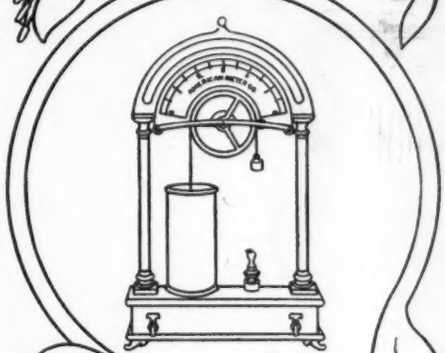

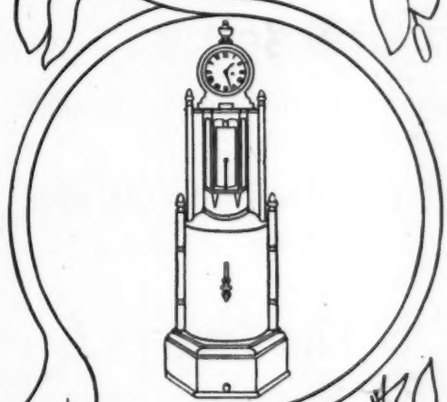

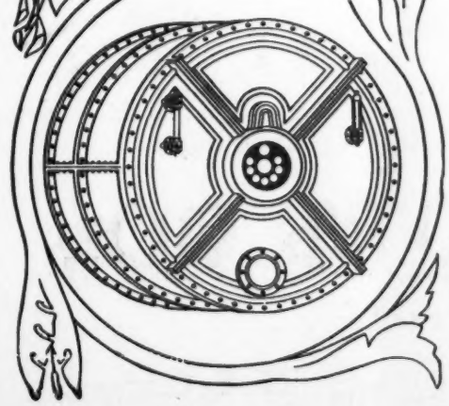

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NEW YORK AND PHILADELPHIA,

CHICAGO, ST LOUIS,

SAN FRANCISCO.

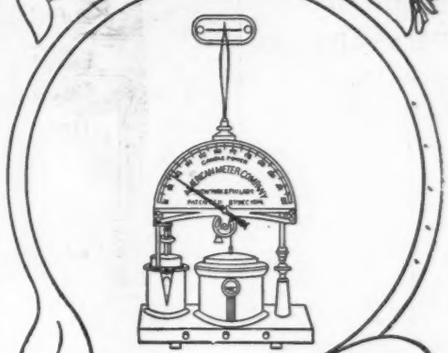
PUBLIC LIGHTING TABLE.

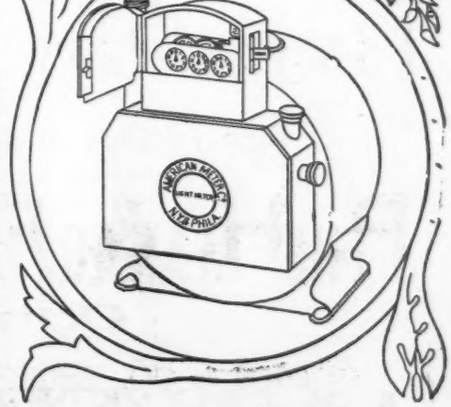
JULY, 1895.

Day of Week.	Date.	Table No. 1. FOLLOWING THE MOON. Light.	Extinguish.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Light.	Extinguish.
				P.M.	A.M.
Mon.	1	11.50 PM	3.40 AM	7.30	3.15
Tue.	2	12.20 AM	3.40	7.30	3.15
Wed.	3	1.00	3.40	7.30	3.15
Thu.	4	1.50	3.40	7.30	3.15
Fri.	5	No L.	No L.	7.30	3.15
Sat.	6	No L. FM	No L.	7.30	3.15
Sun.	7	No L.	No L.	7.30	3.15
Mon.	8	8.00 PM	10.00 PM	7.30	3.15
Tue.	9	8.00	10.20	7.30	3.15
Wed.	10	8.00	10.50	7.30	3.15
Thu.	11	8.00	11.10	7.30	3.15
Fri.	12	8.00	11.30	7.30	3.15
Sat.	13	8.00	11.50	7.30	3.15
Sun.	14	8.00 LQ	12.10 AM	7.30	3.15
Mon.	15	8.00	12.30	7.30	3.15
Tue.	16	8.00	1.00	7.20	3.15
Wed	17	8.00	1.40	7.20	3.15
Thu.	18	8.00	3.50	7.20	3.15
Fri.	19	8.00	3.50	7.20	3.15
Sat.	20	8.00	3.50	7.20	3.15
Sun.	21	7.50 NM	3.50	7.20	3.15
Mon.	22	7.50	3.50	7.20	3.15
Tue.	23	7.50	3.50	7.20	3.15
Wed.	24	7.50	3.50	7.20	3.15
Thu.	25	7.50	3.50	7.20	3.15
Fri.	26	9.00	3.50	7.20	3.15
Sat.	27	9.20	3.50	7.20	3.15
Sun.	28	9.50 FQ	4.00	7.20	3.15
Mon.	29	10.20	4.00	7.20	3.15
Tue.	30	11.00	4.00	7.10	3.30
Wed.	31	11.50	4.00	7.10	3.30

TOTAL HOURS LIGHTING DURING 1895.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	237.00	January	423.20
February	196.40	February	355.25
March	195.50	March	355.35
April	165.30	April	298.50
May	153.40	May	264.50
June	138.20	June	234.25
July	146.30	July	243.45
August	152.50	August	280.25
September	165.10	September	321.15
October	186.10	October	374.30
November	204.10	November	401.40
December	219.30	December	433.45
Total, yr.	2161.20	Total, yr.	3987.45





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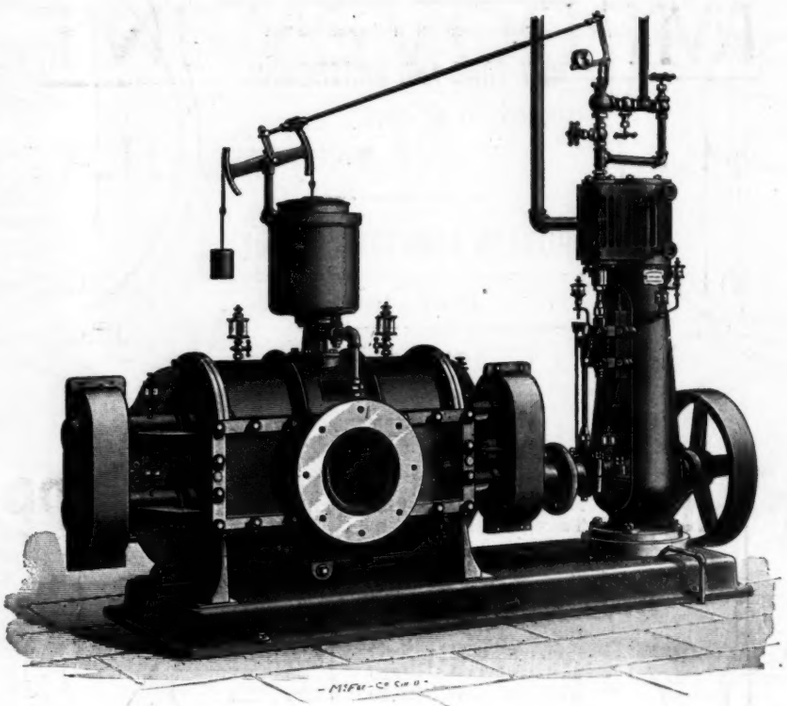

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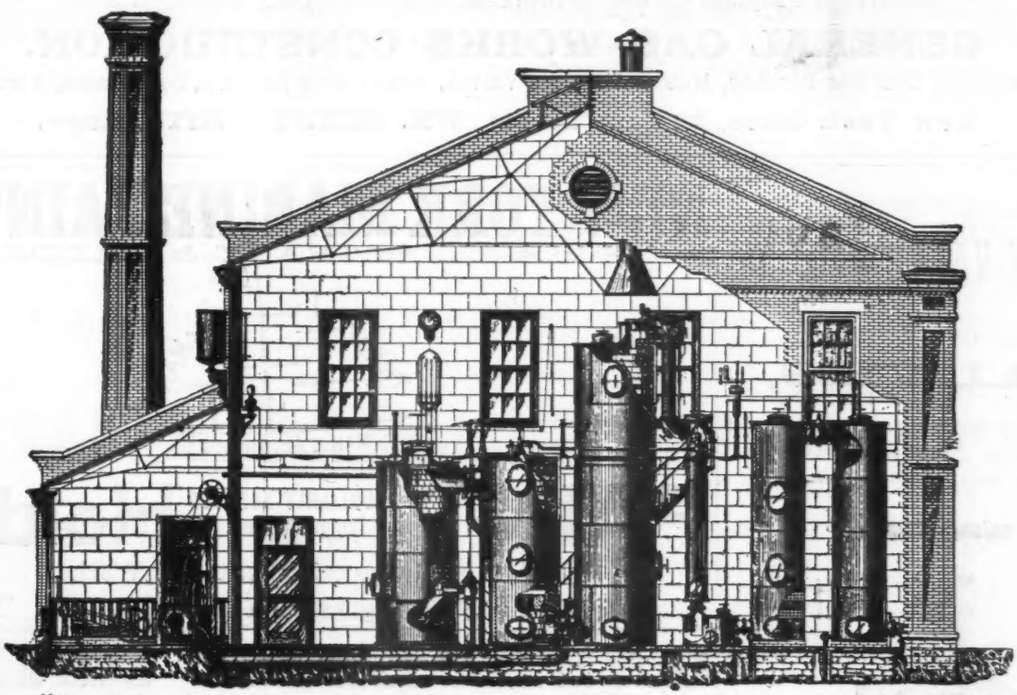

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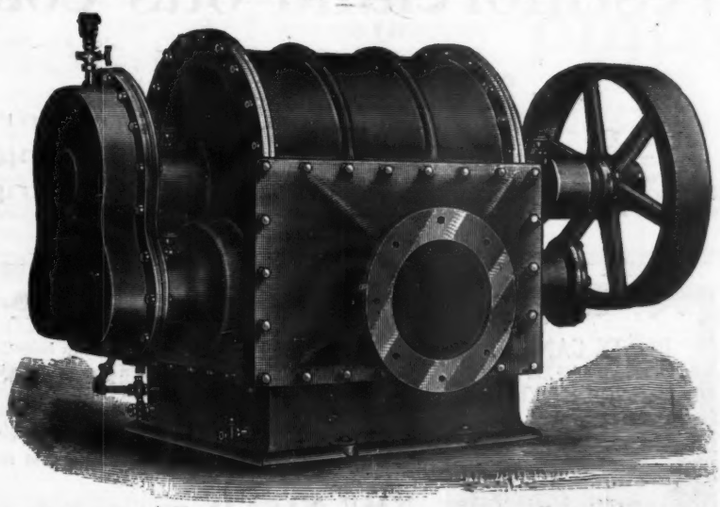

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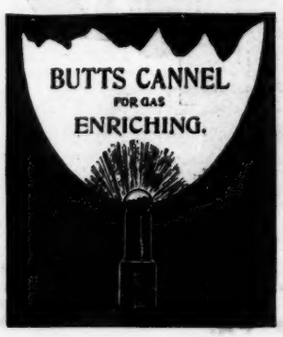

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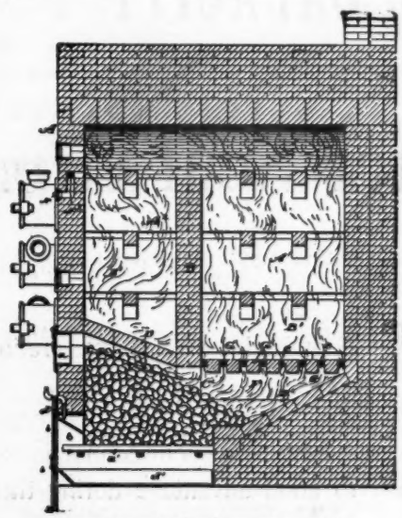

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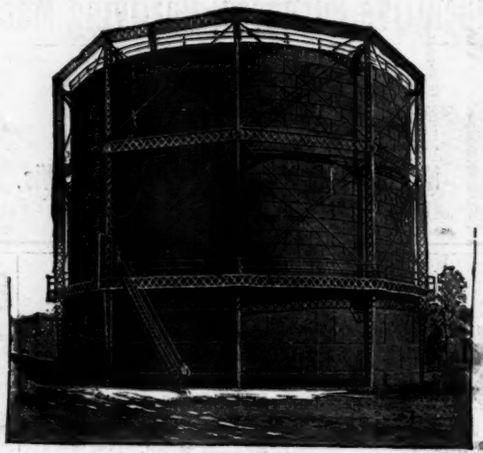

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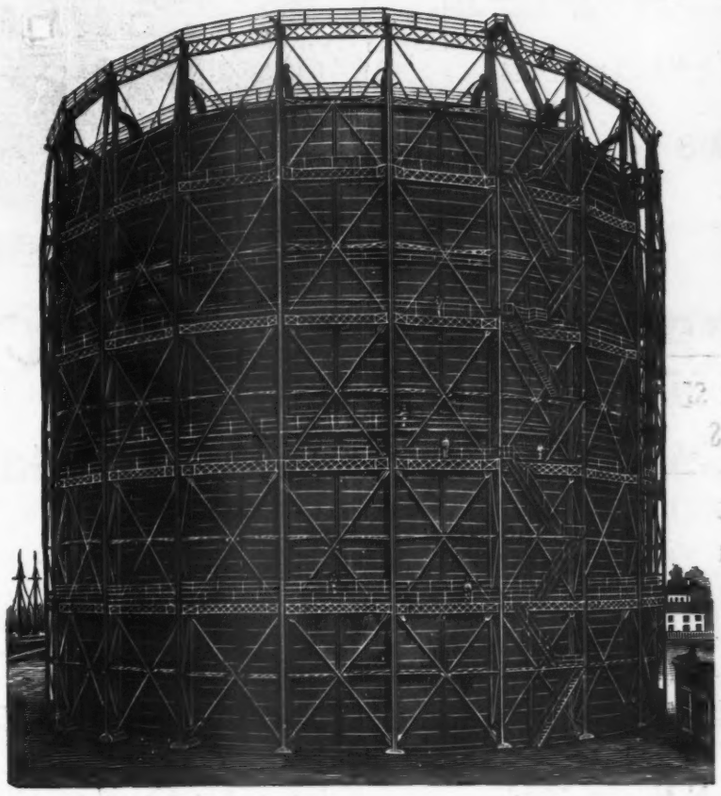

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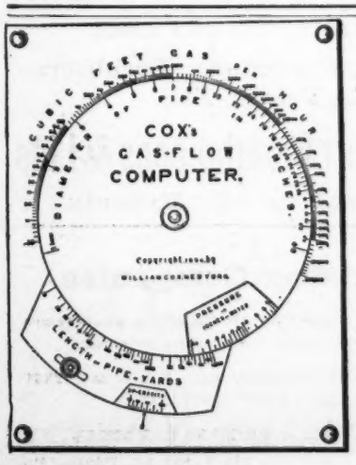

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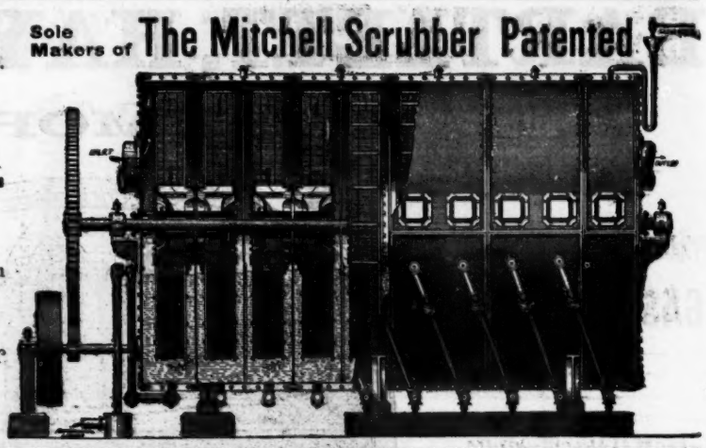

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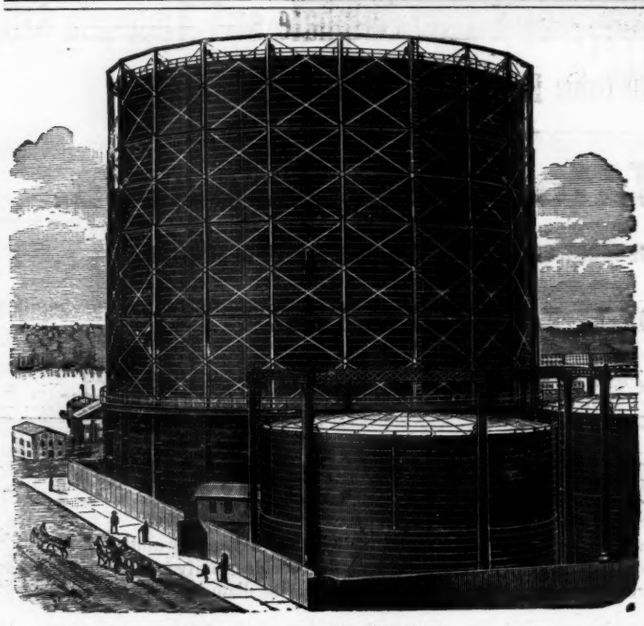

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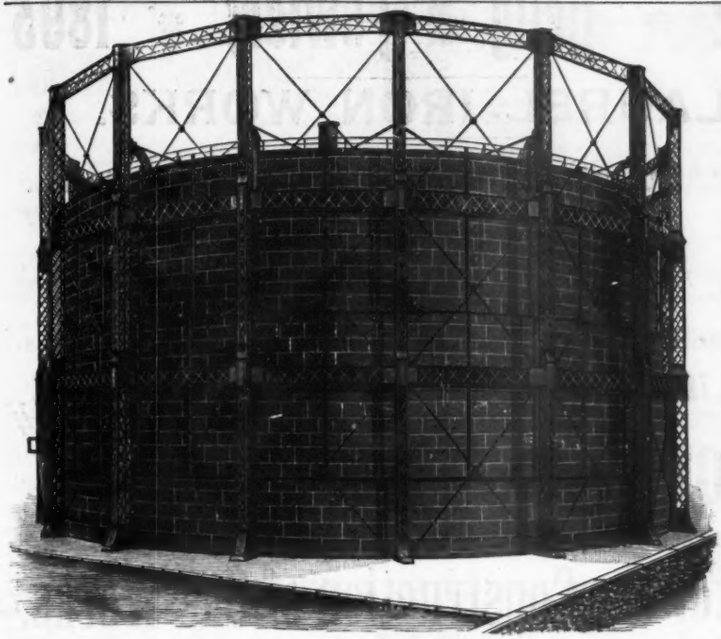

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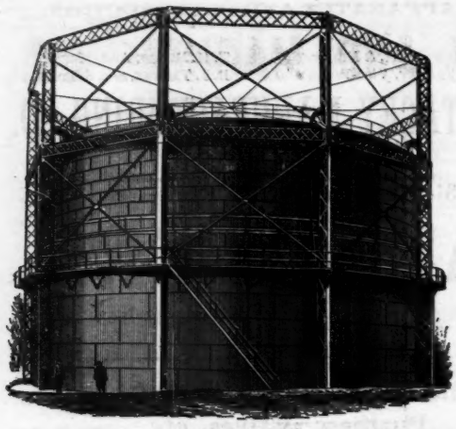

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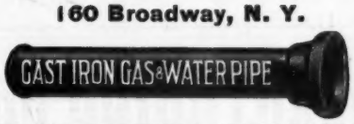

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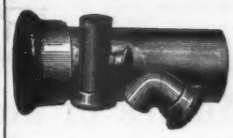

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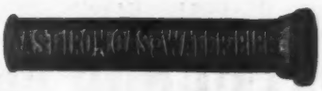

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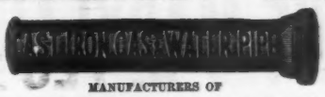

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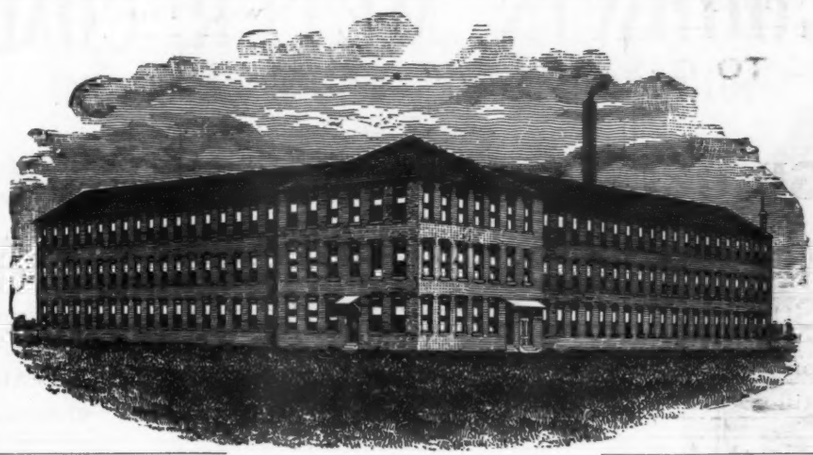

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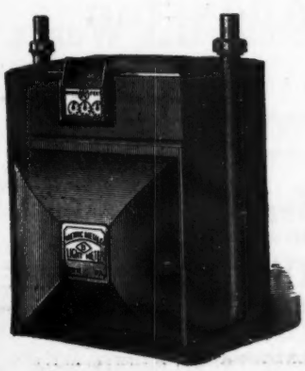

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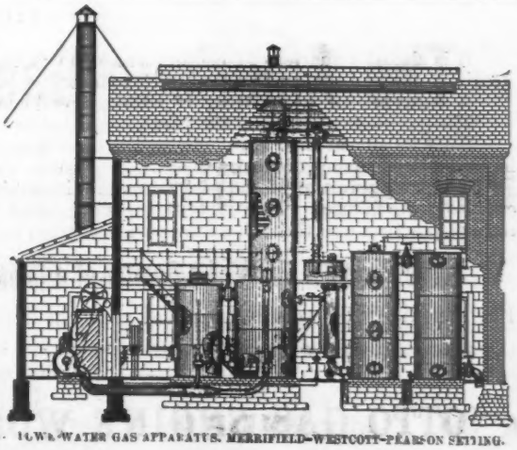

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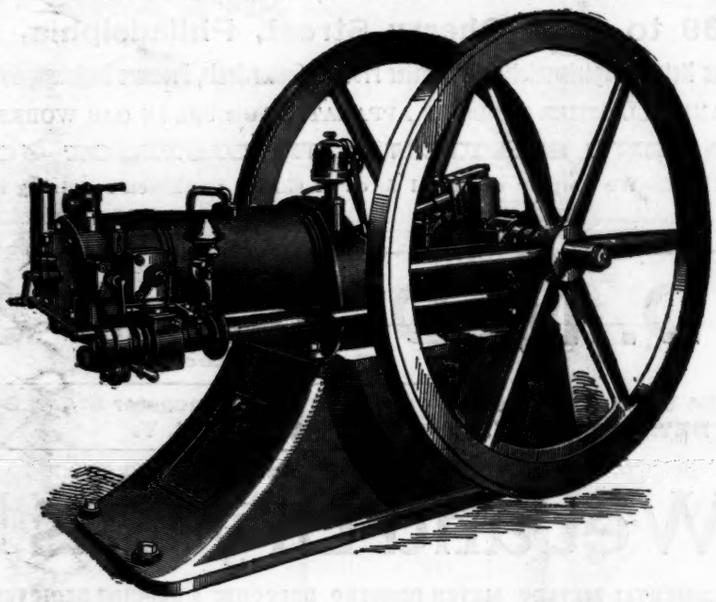
With timing device for ignition, preventing starting backward; or with electric igniter.



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